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THE GROSS EARNINGS OF RAILWAYS for the month of November, 1891, show a very satisfactory increase over those for the corresponding month of 1890. According to the *Financial Chronicle* 142 roads operating 90,953 miles, exhibit earnings aggregating $49,487,624, against $45,226,208 for the same month of 1890, an increase of $4,261,416, or 8.54%. The grain-carrying roads, as might be expected, show the largest gains. Nearly all the roads, both large and small, in the Northwest and Southwest, affected by the grain and live stock movement, show an exceptionally large business for the month. Aside from the grain-carrying roads the results are somewhat irregular. Some of the larger have done well, but a very large percentage show decreases.

THE NICARAGUA CANAL PROJECT has been heartily indorsed by the New York Chamber of Commerce and recommended to the support of the American people. A committee has been appointed to act on behalf of the Chamber.

NINETY-POUND STEEL RAILS are being substituted for those of 70 lbs. per yard on the Manhattan Elevated Railway in this city. Experience has proven that the heavier rail wears longer in proportion and is generally more satisfactory. The south-bound track on the 9th Ave. line has been supplied with the 90-lb. rail and the main road from 104th St. to 135th St. is so laid.

THE NEW ST. LAWRENCE CANAL, previously mentioned as decided upon by the Dominion Government, will take an inland route, 13¾ miles long, on the north shore of the St. Lawrence River, between Lake St. Louis and Lake St. Francis. It will avoid the Cascade, Cedar and Coteau Rapids. The new canal will have six locks and one guard lock, each 270 ft. long, 45 ft. wide and designed to pass vessels drawing 14 ft. of water. The bottom width of the canal will be 100 ft. Including the purchase of land, the estimated cost is $4,750,000.

GERMAN-SILVER BULLETS for small arms are being experimented with at the Frankford Arsenal, in Philadelphia. This metal is said to be the purest yet submitted to test with the later high explosives, and the least affected by heat.

GUNBOAT NO. 5, THE *Machias*, launched at Bath, Me., on Dec. 8, is 190 ft. long on the load water line, 32 ft. extreme beam and 12 ft. draft. Her displacement is 1,050 tons, with 1,600 I. HP. She has twin screws; vertical, inverted, triple expansion engines, with 15¾, 22½ and 35-in. cylinders, 24-in. stroke and 200 revolutions per minute. The screws are made of manganese bronze, 3-bladed, 7 ft. 9 ins. diameter and 3ft. 9 ins. pitch. Her speed is to be 14 knots, and with a coal bunker capacity of 250 tons, her coal endurance at full speed is to be 2,452 knots; at 10 knots per hour her endurance would be 4,668 knots. The vessel is rigged as a two-masted schooner, spreading 6,500 sq. ft. of sail. Her main battery will consist of 8.4-in. rapid-fire breech loading guns, with a secondary battery of 4-6-pdr. and 2-1-pdr. machine guns, and one Gatling gun. There is also a bow torpedo-tube. The main battery is protected by 4 in. steel armor and the machine guns by 1-in. armor. The contract price for two vessels of this type was $637,000, including all but the masts, boats, rigging and armament, which are furnished by the Government.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment and side collision on the Pittsburg, Fort Wayne & Chicago R. R., near Lima, O., Dec. 16. The Columbian express was passing a siding when it was split at the switch, derailing the dining car and two sleeping cars, which were the rear cars of the train, and throwing them against the engine and front of the freight train. The dining car was telescoped by the freight engine, and one of the sleeping cars thrown into the ditch. Four men were killed and 35 or 40 persons injured, some of them seriously. Among the latter were Mr. WM. G. HAMILTON, M. Am. Soc. C. E. Another serious accident was a side collision on the New York Central & Hudson River R. R. at Fishkill, N. Y., Dec. 15. The engine driver of the North Shore express for Chicago failed to apply the air brakes in time at a danger signal, and the train ran into a switch engine with 3 coal cars, which was pulling out from a sidetrack. Both engines were wrecked, one man was killed and another fatally injured. The signal had been set to protect a train which had broken down north of Fishkill.

AN IRON HIGHWAY BRIDGE over Little Blue River, at Shelbyville, Ind., gave way Dec. 11 under two teams. The bridge is said to have been condemned some years ago.

RAISING THE TRACKS of the Chicago, Burlington & Quincy R. R. within the city limits of Chicago has been reported upon to the Commissioner of Public Works by Mr. L. H. CLARKE, City Engineer. From Western Ave. to the city limits the distance is 2¾ miles, along which the railway has a right of way of 30 ft., with 4 tracks for 2 miles and ¾ mile of 3 tracks. It is recommended that the present street grades be retained and the tracks elevated to give a clear headway of 14 ft., except that some streets will have to be raised to the new track level, as they cannot be depressed enough to pass under that level. An earth bank is impracticable, owing to the width required. It is estimated that a four-track elevated railway of iron or steel, with 6 street crossings per mile, can be built for about $665,000 per mile. Mr. CLARKE, however, is of opinion that a more satisfactory plan would be to construct retaining walls of masonry on the lines of the right of way and to fill the whole width. Abutment walls to be constructed at the street crossings extending the full width of the right of way and connecting with the longitudinal retaining walls. The streets to be spanned by iron or steel structures, with columns placed on the curb lines. This form of structure, allowing for 6 street crossings per mile, is estimated to cost about $600,000 per mile, and would have an available top width of 76 ft., which is ample for 5 tracks.

THE ELEVATION OF THE TRACKS of the Atchison, Topeka & Santa Fé R. R. in Chicago, an immense project which includes provision for several other roads, is to be carried out by the Chicago Elevated Terminal R. R. Co., a corporation formed for that purpose, the necessary agreements having been made between the two companies. The plans provide for a four-track masonry structure 16 ft. high, and extensive station and warehouse buildings on State St. from 12th St. to 16th St. The space underneath the track is to be utilized for storehouses, etc., and the cars will be raised and lowered by hydraulic elevators. In addition to the freight and main line passenger traffic, a suburban service is projected. The terminal company has a capital stock of $25,000,000 and its bonds may be placed in England. Gen. J. T. TORRENCE is at the head of this company, and it is stated that a portion of the construction contracts have already been let, and that work is to be commenced in March, 1892. The proposed elevation of the tracks of the Chicago, Burlington & Quincy R. R. has been reported upon by Mr. CLARKE, the City Engineer, as mentioned in the preceding note, and there is also a project for an elevated railway over the Illinois Central R. R. tracks to accommodate the traffic to the Exposition.

WOOD-MOSAICS manufactured in a purely mechanical way by Mr. BOUGAREL in Paris were lately exhibited in the Palace of Industry, Paris. The scale of colors is extremely rich, as no less than 12,000 different shades can be used, so that the best paintings can be faithfully reproduced in this way. The great advantage of this mosaic is that in case the colors should fade, they can be restored to their original freshness by planing, because the fibers of wood are entirely permeated with the paint. The mosaic, it is said, is durably affixed to boards with the grain at right angles, so that no atmospheric change can affect them.

THE LARGE STEEL BRIDGE over the Ohio River at Kenova, W. Va., on the Ohio extension of the Norfolk & Western R. R., has been completed and opened for traffic. The bridge is of iron and steel, 1,730 ft. long, and consists of 5 spans; a channel span 521 ft. long, two spans 304 ft. long each, and two 301 ft. long each. The trusses are of the bow-string type. On the West Virginia side there is an iron viaduct approach 2,150 ft. long. The base of the rail is 100 ft. above extreme low water. The bridge was built by the Edge Moor Bridge Works, of Wilmington, Del.

AN ELECTRIC RAILWAY is projected to connect the cities of Ironton and Ouray, Colo. These two places, which are only about 5 miles apart, are separated by a precipitous mountain ridge, over which it has been considered an impossibility to construct a railway. The Ouray & Ironton Electric Railway, Light & Power Co. has been chartered, with OTTO MEARS, of Denver, Colo., as President, to build the proposed line, and a correspondent informs us that surveys will begin as soon as the weather permits in the spring.

A MARINE RAILWAY has been built by the New Jersey Dry Dock & Transportation Co., at Elizabethport, N. J. The structure is 725 ft. long, 80 ft. wide, and runs into 25 ft. of water on 4 tracks. It is capable of hauling out a 2,500-ton ship in 9 minutes.

THE WHALE-BACK STEAMER, *Charles W. Wetmore* has arrived at Astoria, Ore., after a voyage around Cape Horn. The *Wetmore* left Philadelphia on Sept. 19 with a cargo of machinery; she touched at Montevideo on Oct. 20 and reached Valparaiso on Oct. 5. She passed San Francisco on Dec. 4, but lost her rudder about that point and was towed to Astoria by the steamer *Zambesi*. Her whole trip is regarded as a signal success by the American Steel Barge Co. the owners.

ELECTRICAL ENGINEERING is made the subject of a four-years course at Columbia College in this city. This is in addition to the present two years' post graduate course, in operation for several years past. The new course is established on lines parallel to the regular courses in mining and civil engineering, chemistry, &c., at the School of Mines, with the same requirements for admission. The professors in charge are Drs. CROCKER and PUPIN. The degree to be given is that of Electrical Engineer, and examinations for entrance will be held in June and September of each year.

THE BEIRA-BUIXA RAILWAY, which was opened for traffic last Septembor through one of the most fertile districts of Portugal has much heavy work. For nearly its whole length the country is mountainous, which necessitated the building of 64 bridges and viaducts from 33 to 1,444 ft. in length; and 10 tunnels, the longest measuring 21,191 ft. in length). Bridges and tunnels amount to 2½% of the whole length. The exact length of the road; however, we do not find recorded in the German exchange from which we take this note.

The Comparative Merits of Various Systems of Car Lighting

(The previous articles in this series have appeared in the issues of April 18 and 25, May 2, 9, 16 and 23, Aug. 15, 22 and 29, Sept. 5, 19 and 26, Oct. 10 and 17, Nov. 14 and 21 and Dec. 5).

XIII.

THE COMPARATIVE PHOTOMETRIC VALUE OF OIL, GAS AND GASOLINE LIGHTS.

As stated in our issue of April 18, photometric tests of the different systems of car lighting were made for this journal by Mr. W. B. D. PENNIMAN, Chief Chemist of the Baltimore & Ohio R. R., in the laboratory of the Johns Hopkins University. The photometer used by Mr. PENNIMAN (the Dibdin radial photometer) was described in our issue of April 25, and the description which follows of the tests, with their results, was then intended for publication in the following issue.

But in making these tests, besides determining accurately the light given out from the various lamps, careful measurements were made of the amount of illuminant burned; and in making these measurements it was discovered for the first time that the Frost gasoline system, instead of burning carbureted air, or air saturated with gasoline vapor, as claimed by its makers, was burning most of the time nearly pure gasoline vapor. The evidence was strong from this that the gasoline in the carbureters was being boiled by the heat from the lamp; and an investigation of this matter was made, with the results reported at length in our issue of Aug. 15, and showing as clearly as experimental evidence could well show anything, it appears to us, that such boiling of gasoline was a common if not invariable feature of the plant as then being manufactured and introduced by the company.

The reader will now understand the reason why the publication of the exceedingly valuable and important series of tests below was delayed until after a description of each of the various systems had been published. It was impossible to judge fairly the photometric results obtained from the gasoline system until it was known whether the gasoline was burned under the same conditions as in ordinary practice.

It was represented to us that Mr. FROST, the inventor of the carbureter system, who himself set up the carbureter and lamps used by Mr. PENNIMAN in testing this system, was so anxious to get a high candle power that he made the apparatus burn much richer gasoline vapor than is usual in regular practice. The carbureter manufacturers themselves, however, made no claim of this sort. In fact, they could hardly do so, as their own representative had set up the carbureter and directed its working. Since then, too, other tests, described in our issue of Aug. 25, have proved pretty conclusively that the carbureter system in these tests was worked with no richer vapor than it often uses in regular service (if we except the considerably different system used on the Pennsylvania Railroad, as to which no records are available). We may therefore conclude that the results in candle power given below for the carbureter or gasoline system fairly represent what may be obtained from the plant in the form tested in ordinary practice, the vapor burned being nearly pure gasoline steam with little admixture of air.

We regret that we have been unable to obtain any photometic record of the inverted Lungren burner when burning gas from the carbureter plant as introduced and now used on the Pennsylvania Railroad. The results from this form of the plant with the burners first used (and still largely used) are shown in Figs. 7 and 8. The far less candle power shown in these diagrams as compared with Fig. 6 would seem to indicate that there is much truth in the claim that the Pennsylvania form of the plant does not produce a gas in which gasoline steam in excess of the capacity of saturated air is burned; but what, if any, difference would result in the candle power shown in Fig. 6, if the burners were supplied with this different gas, we are unable to say. It proved impossible to arrange for the further tests which we desired to have made.

The same facilities were extended to each of the companies controlling each system of lighting in setting up their apparatus and regulating its working. As stated above, the inventor of the Frost carbureter system set up that plant to his satisfaction. The Pintsch gas plant was set up by Mr. R. M. DIXON, Chief Engineer of the Safety Car Heating & Lighting Co., which controls the system in this country. The oil lamp fitted with the Belgian burner was furnished complete, ready for testing, by the Belgian Lamp Co., of 31 Barclay St., New York City, and the standard mineral sperm oil in use on the Baltimore & Ohio R. R. was used in the fount.

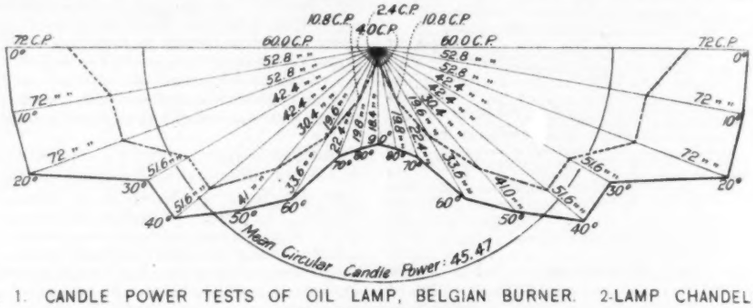


FIG. 1. CANDLE POWER TESTS OF OIL LAMP, BELGIAN BURNER. 2-LAMP CHANDELIER. 7 OZ. OIL PER HOUR.

(Dotted line and interior figures show results without shade. Full line and exterior figures show results with common white porcelain shade.)

PHOTOMETRIC STANDARDS USED.

Photometry is the measurement of the relative amounts of light emitted from different sources. The methods employed always consist of the determination of the relative distances at which two sources of light produce equal intensities of illumination. The relative intensities of the lights are then to each other inversely as the squares of their distances.

The unit of measurement is the light emitted by one sperm candle (made 0.85 in. in diameter and six to the pound), burning at the rate of 120 grains per hour. The "standard candles" are specially made for this purpose, and are all imported. In practice two are almost always used, and a correction is

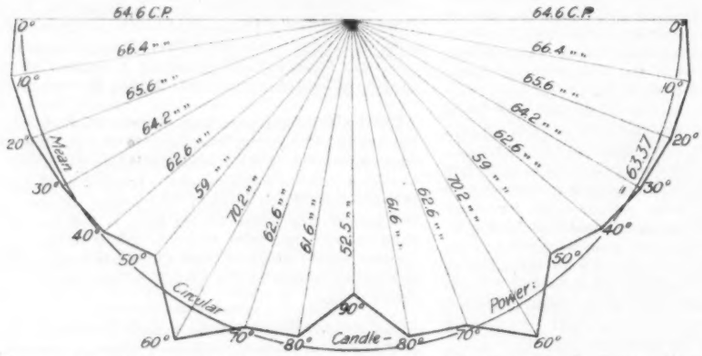


Fig. 2. Present Form of 6-Flame Burner, Average of 10 Tests, 4.72 Cu. Ft. Gas per Hour.

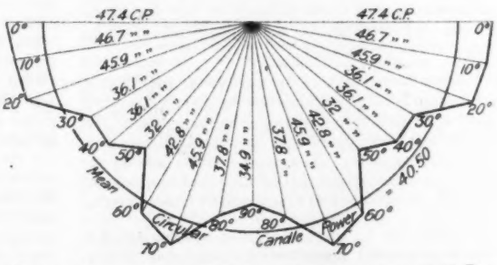


Fig. 3. Present Form of 4-Flame Burner, Average of 12 Tests 2.75 Cu. Ft. Gas per Hour.

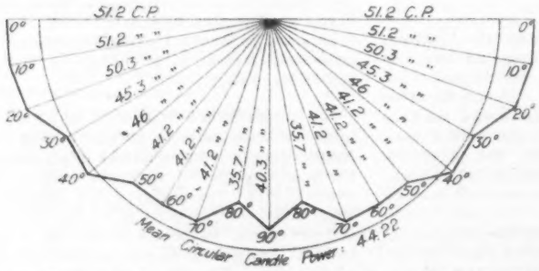


Fig. 4. Old Form of 6-Flame Burner, Average of 10 Tests, 3.65 Cu. Ft. Gas per Hour.

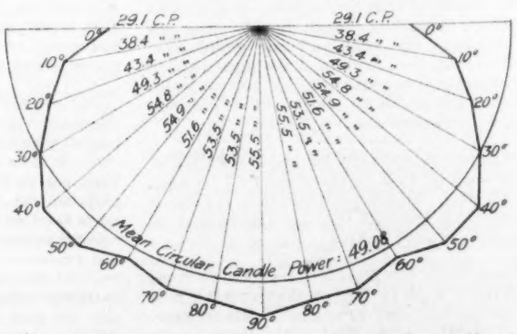


Fig. 5. Porter Regenerative Burner, 3.0 Cu. Ft. Gas per Hour.

CANDLE-POWER TESTS OF VARIOUS FORMS OF PINTSCH OIL-GAS BURNERS

made for the variation of candle burned. The results are rejected if this variation exceeds 6 grains on either side of the prescribed quantity.

The use of candles, however, in a test extending over some time is hardly feasible, especially when powerful lights are to be tested, on account of the great difficulty of securing proper conditions. These can only be secured even for a short time by considerable patient attention and skill.

As the intensity of the lights varies inversely as the squares of their distances, it is evident that when the distances from the screen are approximately equal, any inaccuracy in placing the standard makes a much less serious error than if a lower standard is used.

In the tests herewith recorded, as the standard was to be moved constantly and the lights to be tested were of an intensity many times greater than the light from two candles, it was decided that a light of greater power was desirable.

For example, suppose it were attempted to test a 50 c. p. light by a 1 c. p. standard, and let the distance between the two lights be D. Then the screen would stand at a distance of $\frac{1^2}{50^2}\ D$ from the 1 c. p. light or .0004 D, and a change of say 1 c. p. to 49 c. p. would only require the screen to be moved to $\frac{1^2}{49^2}\ D$ from the 1 c. p. light or $\frac{1}{2401} = .000417\ D$, a difference of only 0.000,017 D, or .0017 in. if $D = 100$ ins. On the other hand, if the same 50 c. p. light is being tested by a 20 c. p. standard, the distance of the screen from the standard light will be $\frac{20^2}{50^2}\ D = 0.16\ D$. A loss of 1 c. p. will then require the screen to be moved to $\frac{20^2}{49^2}\ D = \frac{400}{2401}\ D = .16674\ D$, a difference of .00364 D or 0.364 ins. if $D = 100$ ins., a movement about 400 times as great. It is thus plain that the nearer the adopted standard corresponds in candle power to the light to be tested, the greater will be the possible accuracy of the test.

The standard used in these tests was the light issuing from a slot on the chimney of an Argand burner. This slot was adjustable in size; and it was set to 10 c. p. by means of an ordinary Bunsen photometer. One of the candles was then extinguished, and the screen was moved to the point where the light was equal on each side of the screen. If this reading did not indicate a candle power of exactly 10 candles, the operation was performed again. Two slots were standardized in this way and finally one was tested against the other.

The slots were tested again at the expiration of the evening's work, and the results were rejected if any change in intensity was noted. The "standard light" used in the tests was varied according to circumstances.

The greatest variation admitted in results does not exceed 4%. All proper precautions were taken, by the use of suitable screens, against errors due to the glare of reflected light in the operator's eyes.

As already noted, the ordinary method of determining candle power has been heretofore by horizontal measurements only, that being a sufficiently accurate mode of measurement for ordinary lamp, gas or candle flames, in which the horizontal rays are the strongest. For many of the modern forms of burners, however, as also for all forms of electric lights, and for all lights of any kind in which the light is thrown downward from reflectors or from an inverted burner, this is a most inadequate unit of comparison, and the modern practice for accurate light measurements is far better, viz., to determine the candle power on a series of equidistant angles below the horizon, from which a "mean circular candle power" is determined. In this way, and by the methods above described, all the following diagrams of candle power (Figs. 1 to 8) were determined as tabulated in Table I.:

TABLE I.—CANDLE POWER OF VARIOUS CAR LIGHTS FOR EACH 10 DEGREES OF ARC BELOW THE HORIZONTAL.

Kind of light and burner used.	Belgian oil, 2 lamp chand'r.		Pintsch Oil-Gas Burners.				Frost Carburetors.			Factor for computing visual units.
	Without shade.	With shade.	Present, 6-flame.	Present, 4-flame.	Old 6-flame.	Porter regen've	Present, Lungren.	Old Ex. cylinder.	Old Duplex P. R. R.	
Fuel per hour.	7.00oz.	7.00oz.	4.72 cu. ft.	2.75 cu.ft.	3.65 cu.ft.	3.0 cu.ft.	3.97 oz.	2¾ ±	2¾ ±	
H_0	60.0	72.0	64.6	47.4	51.2	29.1	80.8	33.1	38.7	0.00
10°	52.5	72.0	65.4	46.7	51.2	28.4	85.0	45.2	38.7	0.03
20°	53.8	72.0	65.6	45.8	50.8	63.4	83.3	43.0	40.6	0.12
30°	47.4	51.6	64.2	36.1	45.8	49.3	81.6	36.1	30.1	0.25
40°	42.4	51.6	62.6	35.1	46.0	54.8	85.7	30.5	24.6	0.42
50°	30.4	41.0	59.0	32.0	41.2	54.9	79.4	27.0	19.5	0.39
60°	19.6	33.6	70.3	42.8	41.2	51.6	77.1	10.8	17.0	0.75
70°	10.8	22.4	62.6	45.9	41.2	52.5	71.1	7.4	11.1	0.86
80°	4.0	19.8	61.6	37.8	33.7	58.5	71.1	5.1	6.6	0.97
90°	2.4	18.4	52.5	34.9	40.3	55.5	74.4	4.8	4.5	1.00
Circular mean.	31.82	45.47	63.37	40.50	44.22	49.08	79.10	25.84	23.31	....

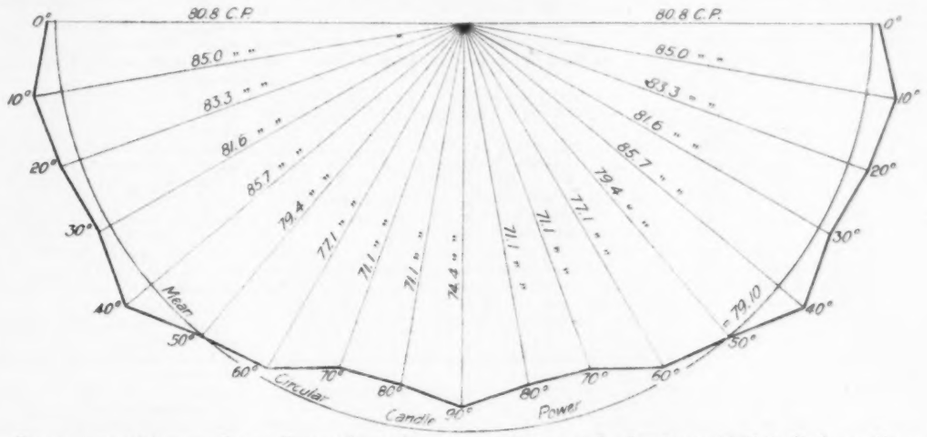


Fig. 6. Inverted Lungren Burner (Present Form). Average of 10 Tests, 3.97 Oz. Gasoline and 1.78 Cu. Ft. Air per Hour.

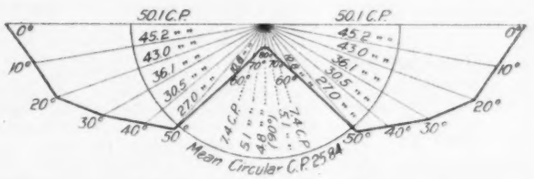


Fig. 7. Old Excelsior Burner.

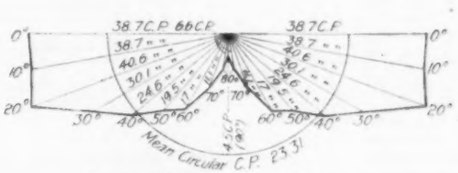


Fig. 8. Dudley's "P. R. R." Burner.

CANDLE-POWER TESTS OF VARIOUS FORMS OF BURNERS USED WITH FROST GASOLINE SYSTEM OF CAR LIGHTING.

But it will be apparent that, from the nature of a candle-power unit, it is only a comparative one, and gives no measure of the absolute illumination from a lamp at any given distance. The same light has the same candle power at all distances, though the absolute intensity of its light decreases as the square of the distance. What we really wish to know about car lamps for car lighting, however, is the relative amount of light which they make available in what we may call the VISUAL PLANE of a car, viz., the plane in which a book or other object on which light is needed is held by an average passenger. This plane, as will be seen from the upper part of Fig. 10, is about 4.5 ft. below the car lights when placed at their usual height. To represent the intensity or value of the light supplied *along this plane* at any point, we must plainly introduce some other unit than that of the candle power, which shall take into account the absolute intensity of the light at each point along this visual plane, as well as its relation to a candle-light.

For this end we have used what we may call the VISUAL UNIT of *one candle power at a distance of 4.5 ft.*, that being the usual vertical distance in passenger cars between the source of light and the "visual plane" where light is needed by passengers. The manner of determining this "visual unit," as also the number and distribution of the visual units from each of the sources of light tested, is indicated in Fig. 9.

The visual units (V-U) are thus determined:

Designating the source of light as L, and the candle power of any ray as C-P, for any ray vertically downward from L to the visual plane we have, by definition:

$$V\text{-}U = C\text{-}P.$$

For any other ray of candle-power C-P^1, standing at an angle of D° *with the vertical* (the candle-power diagrams, Figs. 1 to 8, have the angles recorded from the horizontal), we have for the visual units in the ray at the point where it strikes the visual plane:

$$V\text{-}U^1 = Cos^2\ D \times C\text{-}P^1$$

since the intensity of the ray varies inversely as the square of the distance, and the length of any oblique ray from L to the visual plane is to the length of a vertical ray, as $\frac{1}{Cos\ D}$ is to 1. Therefore, having given the candle-power values of the rays from any source of light, L, at successive angles of 10° from the vertical, we may determine the value in visual units of each ray, at the point where it cuts the visual plane.

(*Continued on page 598.*)

The Drainage of the City of Mexico.

(*Concluded from page 571*).

DISCHARGING CAPACITY OF THE SEWERS.

To determine the discharging capacity required in the sewers, I made a careful study of the rainfall in Mexico, and found that on the average a rainfall of more than 1 in. per hour occurs in Mexico once in two years. I had to take into consideration that all the best authorities in matters of drainage of large cities are agreed that it is quite unnecessary and even very inconvenient to adopt a system of drainage for the exceptional cases of such rain.

The special case of Mexico City presents less difficulties for providing for extraordinary cases, as the ground is very nearly level and the water precipitated in different parts of the city does not run on the surface and accumulate in other parts, and hence the water can never do any serious damage. This fact is fully confirmed in practice, as the present system of drainage of the city has only the fourth part of the discharging capacity which the future system will have, and if some streets are partially flooded the water never rises above a few inches. Besides the above, there are other important considerations to be taken into account, and one is that the drainage canal can pass only 66,000 galls. of water per minute.

To determine the amount of water which reaches the sewers, I employed the formula of BURLI-ZIEGLER, and at once I knew by this the amount of water for which each sewer ought to give passage in proportion to the area. I accepted for determining the velocity the formula which the Drainage Commission of Massachusetts derived from that of KUTTER, and with these elements I formed the accompanying diagrams 1 and 2, by the aid of which it is very easy to determine the dimensions which any sewer ought to have, once we know the superficial area to be drained and the fall which it is to have.

By means of these diagrams the dimensions of all the sewers shown in the plan were calculated with the greatest ease. The principal collecting sewers have an increasing section, while the sections of the lateral sewers vary very little, in general, and those of the distributing sewers not at all.

These differences arise from the fact that the principal collectors increase the area which they drain as they proceed, while the distribution sewers discharge the whole of their water through each lateral into the main sewer. With regard to these lateral sewers I had to bear in mind, beside the considerations of the capacity for discharging, the necessity that the velocity of the water should never be less than 2 ft. per second, in order that the liquids should carry off the solid matters which always tend to form a deposit in sewers. This circumstance gives them in general a larger dimension than that which is required to drain the small surface which they serve, and for this reason their diameter would only have to be increased in cases where their length was very great. There is no difficulty about making them a little larger than what is strictly necessary, because by means of the water from the distribution sewers it is always possible to half fill the lateral sewers and flush them in the most effective manner.

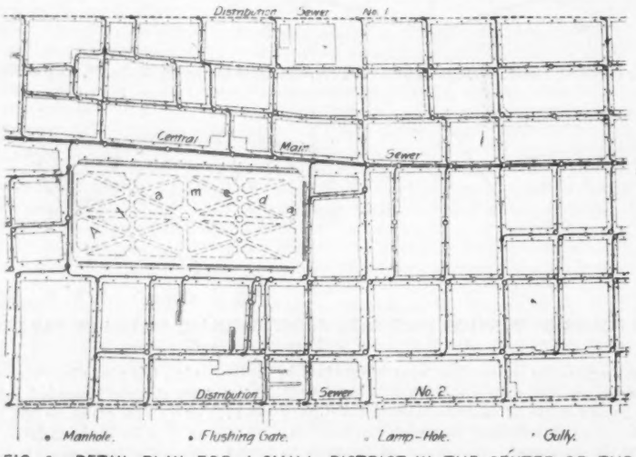


FIG. 3. DETAIL PLAN FOR A SMALL DISTRICT IN THE CENTER OF THE CITY, GIVING ARRANGEMENT OF MANHOLES, FLUSHING GATES, ETC.

FORM OF CROSS SECTION FOR THE SEWERS.

In all the cities where large drainage works have been undertaken, the method which has almost invariably been followed is to give the sewers of small and very large section a circular form, and to those of intermediate size an egg-shape section; and this practice, which is amply confirmed by experience, is that which I have thought best to adopt, seeking as far as possible to reduce the number of different types.

The circular forms vary, first, between 30 and 60 cm., and afterward between 1.25 m. and 3 m. Those of egg-shape form I determined should be of five distinct classes whose relative sizes can be seen in the drawings on inset sheet published Dec 5.

The circular form in the whole length of our main sewers does not present any difficulty, as they can be provided with an abundant supply of water all the year round.

JUNCTIONS AND CONNECTIONS.

All the considerations that I had to bear in mind in regard to the manner of arranging the connections with the sewers, led me to establish the following rules as to the way in which such connections should be made throughout the City of Mexico:

1. Whenever two or three sewers make a junction in one point, the invert at the point of intersection shall be so constructed as to carry the cylindrical surfaces as far as is practicable. This practicable limit will be determined for each particular style of junction, but the general form is indicated in the details shown [in our inset of Dec. 5.—ED.]

2. These junctions are to be covered with a funnel arch as represented in the detail plans [see inset of Dec, 5.—ED.] or with any other arrangement that can be substituted for it, if it is found more convenient on account of facility of construction or economy.

3. The junctions will be made by means of curves of the longest possible radius when the sewers are of large or medium dimensions, locating them so that their center lines will unite in a tangent; but if the sewer is of small dimensions, the curve of junction will be all within the man hole.

4. In the case of small sewers the inverts will be prolonged according to the system established in the first rule.

5. In every case it will be necessary to take care that the bottoms of the branch sewers have sufficient altitude to bring the level of the water within them to the same level as in the main sewer into which they discharge, assuming the height of the water in the latter as that which it would probably have for 90% of the time.

6. The house drains ought to enter the sewers at an angle of 30° at least, and at a point above the ordinary level of the water within the sewer, when it is not situated at any great depth, because if it is, it would be convenient to make the entry higher up to facilitate the construction.

7. When two house drains or small size sewers meet in a manhole opposite one to the other, one of the two ought to be pushed forward a little in order that when they are completely full their currents should not meet, as would happen if they discharged exactly opposite to each other.

8. At the time of constructing the sewer the connections for all the house drains will be placed, and not only those which are to be immediately used, but also those whose necessity can be foreseen; and those which are not at once used will be covered and a careful note taken of them in a special register drawn in such a manner that whenever any one of them may be wanted its exact position can be fixed without any trouble.

MANHOLES AND LAMP HOLES.

For the manholes and lamp holes I followed the same method, analyzing the practice which has been followed in the principal cities of the world and applying it to the special conditions of the City of Mexico. I thus arrived at the following conclusions:

1. The manholes ought to be of circular section or elliptical when they are placed in sewers of 1 m. or less in diameter; but those of a greater diameter ought to be of square section, although in both cases they will terminate at the level of the street with a circular aperture 2 ft. in diameter.

2. The aperture above spoken of should have a cast iron cover of the figure and dimensions shown [in inset of Dec. 5] this cover should be perforated all through, but the holes on the periphery will be covered with small blocks of hard wood, leaving the holes in the center uncovered for the ventilation of the sewers.

3. In case it should be shown by experience that the small amount of garbage which falls through the holes in the covers should give any trouble in removal by flushing, an iron plate tub can be placed within the manhole as shown in the detail drawings.

4. These manholes should be placed at distances one from the other which might vary between 165 and 500 ft., according to circumstances.

5. When the sewers pass under crowded streets or directly under a railway, the manholes will have to be connected laterally from the sidewalk, as shown, but under all other circumstances the manholes will be made directly over the center of each sewer.

6. Directly over the sewers which are of 3 ft. or less in height, lamp holes will be constructed at distances not above 165 ft., the details of which can be seen in [inset of Dec. 5].

7. At the point of any change in the center line of the sewer, whether in alinement or in grade, there will be a manhole or a lamp hole, according to whether it is a sewer of large or small section.

GULLIES.

With respect to the gullies I studied an arrangement similar to that which they have in Frankfort, Germany, but making them shallower and without any trap for the following reasons:

In Mexico we only have rain generally from April to October, so that if we established as a necessary condition that these gullies should be provided with a trap, it would also be necessary to give them an artificial supply of water, a very difficult matter and one that could never be properly arranged for; besides which, the water that happened to remain in the catch basin would decompose, producing miasmas that would doubtless be prejudicial to health and disagreeable to the smell much more than those of the sewer. For this reason I prefer recommending that they should be cleaned frequently and thus avoid the necessity of large catch basins and do away with the trap.

In Mexico the thermometer never falls below 20° F., and this only as a very exceptional case in the earliest hours of the morning. On the very coldest days of winter the thermometer always rises to 50° to 60° F., for which reason it is perfectly useless to take any precautions against frost, and the water in the catch basins will never freeze however shallow it may be. On account of these and other considerations I have set down the following rules for the construction of gullies in Mexico City.

1. The inlet shall always be in the gutter and covered by a grating.

2. A catch basin shall always be placed under the grating and will be of the size shown in the drawing and formed of an earthenware or iron tube.

3. None of these catch basins will have traps, as one of the rules of the maintenance of the system of sewers must be that the catch basins shall contain water only for a short time, especially in the dry season

4. An iron tub will be placed inside the catch basin in order that the solid matters which ought not to pass to the sewer may be caught therein and taken out with ease and rapidity.

5. The pipe to connect with the sewer will be of earthenware and of 6 ins. inside diameter.

6. Special care shall be taken that the manholes, lamp holes and ventilation holes shall be placed as near as possible to the points where the rain-water drains discharge into the sewer, with the object of preventing the sewer gases from escaping through the inlet of the gullies.

7. The gutters will be formed by the simple depression produced by the crown of the street terminating in the line of the curbstone.

VENTILATION.

In order to determine the best manner of ventilating the sewers, I studied all the systems which have been employed in the world, and the conclusions arrived at by the Metropolitan Board of Works of London, and with these data I established the following rules:

1. The best system of ventilation to be used is that which communicates the sewers with the open air at frequent intervals, in order that there should be no point inside of them where the renewal of air would be in any way difficult.

2. This communication will be established by the man and lamp holes, by the gullies, and by special ventilation holes which will be constructed in the spaces between the others when the distance between them is more than 148 ft.

3. These ventilation holes will all be of one type, and they will have a diameter of 10 ins.

4. The covers of these ventilation holes will be of the same class as those of the man holes.

5. As a general rule the sewers ought not to be ventilated through the house drain, but rather a ventilation hole ought to be built over the house drain, thus obliging the gases to escape in that way rather than enter the house drains.

6. In the distribution of the ventilation holes over the length of the sewers, efforts ought to be made as far as possible to have them placed at the points where the storm water drains connect, in order to prevent the sewer gases from escaping through the inlets of gullies.

7. The rain water pipes from the houses ought never to be used as ventilators, but they ought not to have hydraulic traps, as these would not act except in the rainy season; and the object of this rule is rather to show that these pipes can in no way be relied upon for the ventilation of the sewers.

8. If any factory or industrial establishment where a large chimney exists will consent to the connection of its furnaces with the sewers so that the gases shall escape that

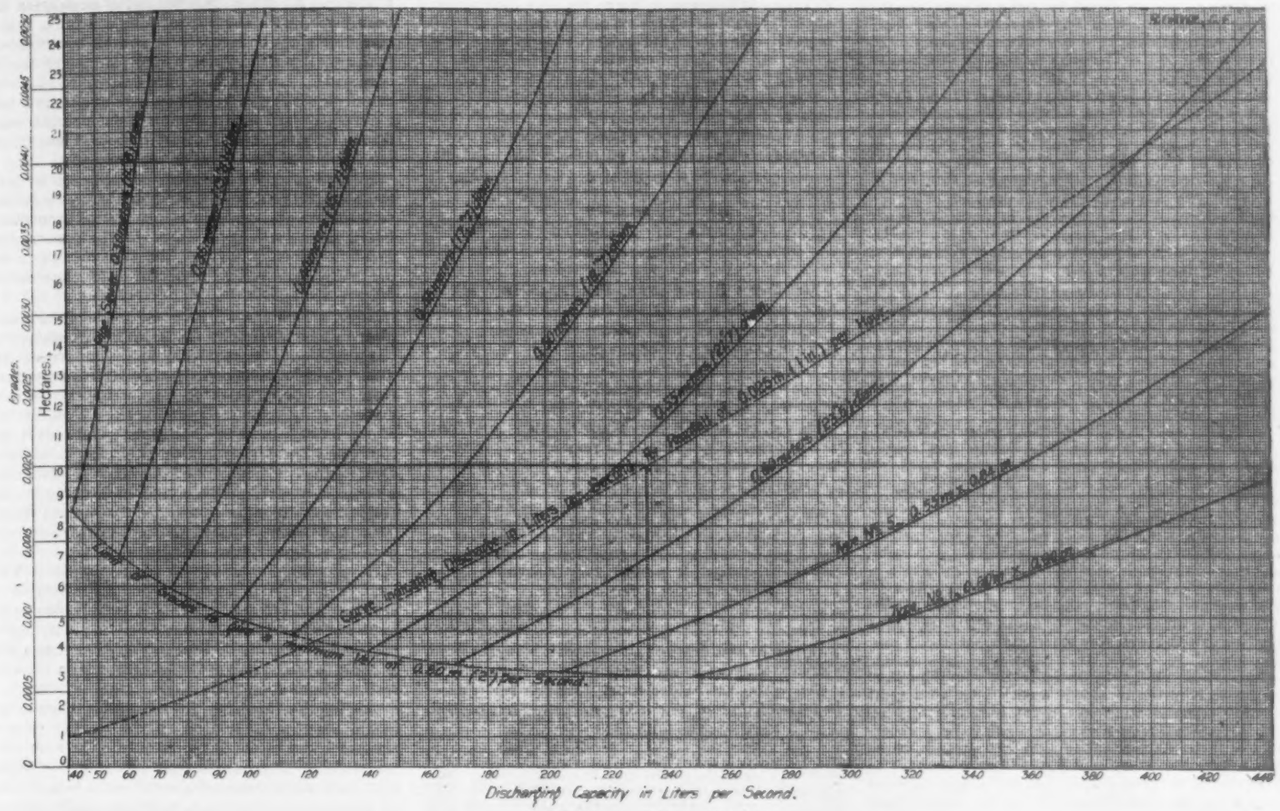


DIAGRAM 1. SMALL SEWERS.

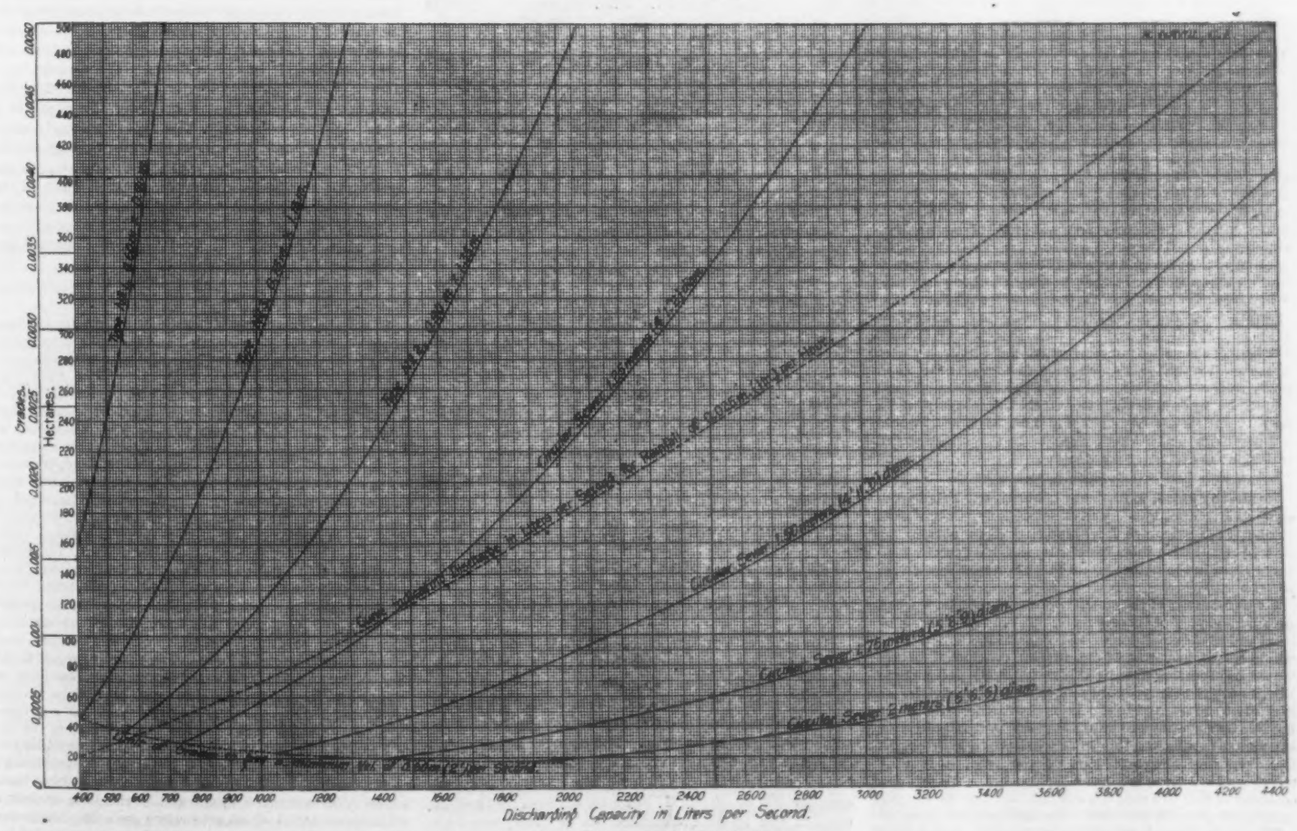


DIAGRAM 2. LARGE SEWERS.

To Use the Diagrams.—Given, area to be drained and available fall on line of sewer. Entering diagram with given area to be drained (as 10 hectares), we obtain from the rain curve the discharge in liters per second (231 liters for 10 hectares) The intersection of the vertical line for the given discharge with the several curves for different types of sewer will indicate the necessary grade for each to produce the given discharge; and, conversely, the position of the intersection of the given vertical with the horizontal line for the given available grade (as .0009) will indicate the proper type of sewer (in this case No. 5). The different types of egg-shaped sewers were shown on our inset sheet, Dec. 5, 1891.

way, the connection should be made unless very expensive. Should the cost of this connection be very high it ought not to be made, because the advantages of this ventilation do not extend for any considerable distance, and therefore we would have to resort to other means in the other parts of the sewers where chimneys do not exist.

9. With the means at our disposal of flushing the sewers under the new system of drainage, there ought to be no escape of noxious or disagreeable gases, but care will have to be taken to clean out the sewers with due frequency, so that once established the presence of any bad odor will be a sure indication of the presence of accumulated matter and of the necessity of flushing the sewer from which it proceeds.

10. Under no circumstances ought the sewers to be ventilated by machinery.

PUMPING STATIONS.

In treating of the discharging capacity of the sewers I stated that the grand canal of the main drainage works has a capacity for the passage of only 66,000 galls. per minute. This applies to the first 12½ miles, but beyond that point the same canal is so far enlarged that it can carry 221,000 galls. per minute, being made so with the object of draining Lake Texcoco.

In a rainfall of 1 in. per hour the city sewers will discharge about this same quantity, and at first sight it might be thought desirable to give the canal the same width in the whole of its length; but against this we must take into consideration that in the whole of the section comprehended between the city and the point where the waters of Lake Texcoco enter, the only liquids to be carried are those expelled by the city, and that during the greater part of the year these will be very scarce, and if the canal were too wide the solid matters would be deposited. In my opinion it would be very unfortunate thus to establish by means of our own sanitary works a future nursery of infection that to-day does not exist.

The drainage of this city demands that the works shall be capable of giving an exit in a short time to a great quantity of water, while on account of the sanitary requirements these same works should only have the capacity that is strictly required to allow the passage of the water disposable at all times, and to satisfy these two conditions at the same time without sacrificing one to the other I have proposed the establishment of pumps capable of removing the excess of water which the sewers carry during very heavy rains, and which would not find room in the canal.

These pumps would only work a few hours in the year, and therefore the cost of fuel, which in other circumstances is such an important factor in Mexico, is really not so in the case of the drainage. The pumps would be required to work only on the rare occasions *when the rainfall exceeds ¾ in. per hour*, because when the rain is of less volume the water can escape without difficulty.

A careful study of our meteorological statistics shows that rainfalls of more than ¾ in. occurred only 252 times in a period of 14 years, an average of 18 per year. In the majority of these cases the precipitation takes place in a period of time sufficiently long to allow the water to escape by means of the canal without any necessity of appealing to the pumps, and when these pumps do have to work, the probability is that in a period of 10 years they will never have to be put in operation for a longer time than 3 hours. But let us suppose that every one of these rains should fall in a period of time that would demand the help of the entire pumping plant for 3 hours on each occasion, it would only amount to 54 hours *in the whole year*, under which circumstances the expense of coal would be insignificant. Therefore the engines must be very simple and economical in first cost, as it would not pay to go to any heavy expense in the purchase and setting up of expensive machinery.

FLUSHING.

As already noted, to flush our sewers it will be indispensable to introduce into the city the necessary waters from the lakes of Chalco and Xochimilco, and to obtain the desired result with these waters it will be necessary to carry them to the highest point in the whole system of sewers.

A careful study of the conditions under which we can procure a supply of these waters, of the differences of level and of the condition of the canals by which they would travel, has brought me to the conclusion that it would be necessary to raise this water at the point where it will have to be introduced into the city to a height of 16 ft. more or less; and as the amount of water which will have to be elevated will be 41,000 galls. per minute and the pumps performing this work will have to be in operation every day the greater part of the year, it is well worth while to spend money on them in order to procure economy of fuel and that the engines should be of the compound type and provided with surface condensers.

This is, in general terms, the application that I have given to the principles of sanitary science with the object of improving the hygienic conditions of the capital of the Mexican Republic. I present it simply as a work of the present day, not as embodying any new principles, and I take great pleasure in this opportunity to publicly tender my thanks to Messrs. RUDOLPH HERING, ELLIOT C. CLARKE and BENEZETTE WILLIAMS, who have received me with the greatest kindness and have supplied me with most valuable data on the drainage of large cities, when in the year 1885 I had occasion to travel through the country studying the subject.

Such of our readers as are able to read Spanish will find in Mr. GAYOL'S full report a much more elaborate and very able discussion of every side of the Mexican sanitation problem. The pamphlet, which contains 93 folio pages, can be obtained by application.

Development of American Pig Iron Manufacture.

Mr. JOHN BIRKINBINE, Prest. Am. Inst. Mining Engineers, in a recent lecture before the Franklin Institute, has given an admirable summary of the growth and prospects of our pig iron industry, from which we make a few notes.

The amazing progress which has been made in the last decade is forcibly brought out by an extract from vol. xv. of the Tenth (1880) Census (not published until 1885, it should be remembered) in which this cautious prediction is ventured:

In 1886 the United States had reached the production of Great Britain in 1835, that is to say she was 31 years behind the latter country. At the end of 1884 she was 21 years behind the latter country. *At the same rate of increase for both countries the United States will be but 15 years behind England in 1900 and will reach and pass her in 1950*, the production of each country for that year being a little over 30,000,000 tons.

Actually the United States "reached and passed" England in 1890, just 60 years before it was predicted, yet only six years after the prediction was made.

The comparative decennial increase per cent. of population and of pig iron production has been in the United States as follows;

	Population.	Pig iron.
1830	..	32.51
1840	91	33.52
1850	79	38.84
1860	46	35.11
1870	106	22.63
1880	126	30.08
1890	140	24.86

In 1855 we were *consuming* 117 lbs. of iron per inhabitant; in 1890 330 lbs., all within our borders.

Mr. A. S. HEWITT and Mr. EDWARD ATKINSON have made predictions for 1900. The two compare as follows:

	Pig iron product of 1900. World.	United States.
Mr. HEWITT'S prediction	35,000,000	15 750 000
Mr. ATKINSON'S "	40,000,000	16,200,000

Mr. BIRKINBINE considers that both of these estimates are somewhat too high.

The two following tables give in small space a very good synopsis of the facts in regard to the growth of the industry:

Tons of Pig Iron Product.

	1860.	1870.	1880.	1890.
New England	26 609	34,778	27 640	30,162
Middle	706,369	1,171,115	2,143,833	4,657,670
Pennsylvania, only	560,949	922,564	1,723,492	4,207,590
Southern	100,761	164,768	311 639	1,582,106
Western	155,829	465,215	892,799	2,283,436
Total U. S.	987,559	1,832,836	3,375 911	8,553,374

The "Southern" group includes all the old slave States and east of the Mississippi; the New England and Middle groups are as ordinarily understood; the "Western" group all the rest of the country.

Inhabitants per Ton of Pig Iron Product.

	1860.	1870.	1880.	1890.
New England	117.87	113.33	145.10	155.85
Middle	10.72	7.83	4.98	2.76
Pennsylvania, only	5 01	3.82	2.48	1.25
Southern	89 06	65.91	44.95	10.26
Western	69.92	32.76	24.11	12.62
Total U. S.	31.84	21.04	14.86	7.32

The Ordnance Bureau's Work.

Commodore FOLGER, chief of the Bureau of Ordnance, in his annual report to the Secretary of the Navy, estimates the expenses of the Bureau for the next fiscal year at $4,780,291, of which $4,188,250 is to be applied toward the armament of new vessels authorized to be built. The number of guns required to arm the new vessels is placed at 347, ranging in calibre from 4 to 13 ins. The guns completed number 155, of which 117 are 6-in. calibre. Although none of the ships authorized to be built requires guns of 16-in. calibre, it is believed that such guns may be needed, so that plans have been made, and authority is sought for construction of one of them. The trials of smokeless powder have resulted satisfactorily, and it is believed that the use of gunpowder will be entirely abandoned in calibres of 6-in. and below it. An order for 50,000 lbs. of gun-cotton has been placed with the Duponts on condition that a complete plant be erected. A notable improvement in the quality of Carpenter armor-piercing projectiles is recorded. Large orders have been given to American firms for forged steel, common shells and electro-welded steel shells; also for 25 one-pounder and 5 6-pounder Hotchkiss guns of increased length, and for 75 six-pounder Driggs-Schroeder guns.

The present state of work in connection with automobile torpedoes and their accessories is such as to justify the belief that the installation of outfits on board vessels will begin early in the coming year. The bureau believes that the submarine gun will prove a valuable and important adjunct to our defensive armament.

Negotiations are in progress to cause the armor-plate to be delivered by the Bethlehem company for the double-turret monitors and the *Maine* and *Texas* to be of nickel-steel, and all armor ordered from Carnegie, Phipps & Co., is to be of the same material, government supplying the nickel, 800 tons of ore having been purchased last year. It is said that the *Vesuvius'* dynamite guns are unsatisfactory, and it is recommended that she be turned into a torpedo cruiser. With a view to utilizing the old single-turret monitors now in the James River, plans have been prepared for new turrets and modern 8-in. or 10-in. rifles for them.

The gun factory at the Washington Navy Yard has proved itself successful in the direction of economy and efficiency. This is largely due to the methods which have been pursued in purifying the manner of making appointments, promotions, &c., in the labor force and in the adoption of an administration based upon business methods.

The results furnished in the armor tests by the nickel steel plate treated by the Harvey process manufactured by the Bethlehem Iron Co. were most remarkable. The bureau considers that two important results have been achieved: First, a better plate, of American manufacture, has been produced than the department was able to purchase abroad a year ago; secondly, it has developed a new principle in the manufacture of armor of American origin, which it is believed will furnish greater protection than any other system. It has been definitely established that armor of excellent quality may be produced by the rolling process, and that forging by the hammer is not absolutely necessary. The report strongly urges the establishment of a national gun factory on the Pacific coast similar to that in Washington. If the feeling in Congress corresponds with that of the general public, there will, we believe, be no delay in providing for this and other like expenditures needed to effectively defend our coast against any possible attack by any power.

Government Maps in Europe.

In all the countries of Europe the necessity has been recognized of having a detailed and accurate map, which should be available for military and administrative purposes. The scales on which these surveys have been published have varied from about 3 ins. to a mile to about 3 miles to an inch. First in point of scale comes Hesse, the map of which is published on a scale of 1 in 25,000, or about 3 ins. to a mile. Belgium comes next, 1 in 40,000; then Baden, Bavaria, Sardinia, Holland, Wurtemberg, Oldenburg, Grand Duchy of Hesse, 1 in 50,000; Saxony, 1 in 57,600; Great Britain, 1 in 63,360 (afterward increased to 1 in 10,560, and again to 1 in 2,500); Denmark France and part of Prussia, 1 in 80,000; Lombardy, Venetia, States of the Church, Tuscany, Parma, Placentia, Guastilla, 1 in 86,400; Hanover, Portugal, Prussia, Sweden, Switzerland, 1 in 100,000; Schleswig-Holstein, 1 in 120,000; Russia in Europe, 1 in 126,000; Austria, 1 in 144,000; Norway and Greece, 1 in 200,000. These surveys have been mostly executed within the present century, and many of them are still incomplete. The survey of Great Britain commenced by the measurement of a base line on Hounslow Heath in 1784. The last country in Europe (excepting Turkey) to recognize the necessity of a government survey was Spain. In the English survey the difference between the length of a base line 7 miles long in the north of Ireland obtained by actual measurement, and that which resulted from triangulation starting from a base in the south of England and carried over the whole of England and Ireland, was only 5 ins. The triangulation of the different countries has been connected together. The last link in the chain was completed in 1861-62 by the connection of the Belgian and English surveys across the north of France and the British Channel. This was effected by simultaneous but independent observations carried on by the French and English engineers.—*London Architect.*

The Baltimore Belt Railroad.

(WITH INSET.)

(Concluded from page 559.)

Naturally enough, the owners of property along Howard St., when they heard that a double track railway was to be built beneath the street in front of their buildings, were a little anxious as to the safety of foundations and the chances that their business would be blocked for a season by the construction of a tunnel in open cut. It was by the open cut method that the Baltimore & Potomac and Union tunnels in the city of Baltimore were constructed, with the exception of a length of 1,100 ft. on the former and 395 ft. on the latter, which were drifted. But while in building the Howard St. tunnel, the open cut method would be much cheaper than tunneling for a part of its length, a considerable portion is located so far below the surface that an open cut would hardly be practicable. The proposal to obstruct the street by an open cut would doubtless have caused a united and formidable opposition on the part of the property owners which might have endangered the success of the enterprise. It was therefore determined to build the line in tunnel from Camden St. to Mt. Royal Ave.

The ordinance passed by the City Council granting a franchise for the construction of the road provides that the tunnels shall be so constructed and covered as to leave uninjured and secure the highways, streets and alleys under which they are made. If in process of construction it becomes necessary to take up any pavement or excavate on any street, the surface shall afterward be restored to the same condition in which it was before being interfered with, the work to be done within the time and in the manner prescribed by the City Commissioner.

The section of the ordinance referring to ventilation provides that no openings or holes shall be made in any street or avenue for this purpose. If the Belt R. R. Co. deems ventilation necessary, it shall erect chimneys, shafts, flues or other appliances at proper points, on its own property, and of such height and construction as to ventilate the tunnel without annoyance to adjacent persons or property.

The diversion or reconstruction of any sewer or the building of any new sewer rendered necessary by the construction of the road shall be done by the railway company under direction of the City Commissioner. The company is also required to protect gas and water mains along its line and make any necessary changes or reconstruction at its own expense. In accordance with this ordinance, levels were taken all over the surface of Howard St. prior to the commencement of the work.

As stated last week, the material encountered is of greatly varying character, but most of it is a rather wet sandy clay. After some canvassing of the matter, it was determined to drive the tunnel with two bottom drifts, enlarging it afterward to full size by driving a single top drift. This system has been found to work admirably. The bottom drifts drain the material through which the top drift is driven, and the water flowing along the bottom can be conveniently handled by the pumps.

In many of these bottom drifts, water enough to fill a 5-in. pipe is constantly flowing. The excavation for the bottom drift is made about 8 ft. wide and 8 ft. high, and is timbered with two posts and a cap, behind which lagging is driven in as tightly as possible to exclude the water. The bottom drifts are advanced by driving poling boards over the leading collar and at the sides; and in most of the work face-boards are used at the front of the drift.

In excavating these drifts two miners and a helper can work in each; and working in two 10-hour shifts an advance of 50 to 90 ft. per month can be made. Ordinarily these bottom drifts are not worked over 25 ft. in advance of the top drift.

In these drifts the side walls of the arch are built. The bottom is excavated until a solid bearing is obtained and if necessary a footing of concrete 1 or 2 ft. deep is put in. The space between the side wall and the outside lagging is packed with dry rubble or rubble masonry. The outside posts are not removed, but the rubble is packed around them. The number of hours of mason work required to build an 18 ft. section of one side wall is about 125.

In ordinary soft ground tunnel work, the sliding in of material over the line of tunnel is of importance only when its quantity is great enough to appreciably increase the amount of excavation, or cause danger to the work or those engaged upon it. In this case, however, it was desired as far as possible to prevent all movement of the material outside the tunnel line, and thus avoid injury to the pipes, pavement and buildings above.

A system of timbering which was used for a short distance (about 40 ft.) in the top drift at shaft No. 1 consisted of timber segments, supported by props resting on the earth center-core and advanced by iron poling pieces. Figs. 1 and 2 on our inset sheet show this method of working. The segment timbers were sawed 12 ins. square and 6 ft. long and were placed close together. The struts supporting them were also placed close together, no stringer pieces being used, and the heading was thus partitioned into separate galleries, which were very small for convenient working.

The iron poling boards used are shown in Fig. 3. They were 5 ft. long, 8 ins. wide, and ¼ in. thick, stiffened by ¾ in. angle irons riveted to their upper edges. The front end was sharpened; and a cross angle iron was riveted on the lower side, by which the poling board was pried forward. The holes in the board were also of use in prying it ahead.

This system of tunneling was used for a short distance in driving the heading south from shaft No. 1, but it worked very badly.

At the point where it was tried the ground is about as difficult to support as at any point on the line of the tunnel. The depth of material over the tunnel roof is over 20 ft., and it is all made ground, possessing so little coherence that practically the whole weight of the superincumbent material had to be carried by the tunnel timbering. The weakest point of this system of working was the lack of any means for guiding the iron poling boards in advancing the heading. It was difficult enough to pry them ahead at all, in the contracted chamber where the men had to work; and the boards gradually worked down in some places and up in others, until the timbering was very badly out of shape, and was so low at the top that the arch could not be built of the proper height. To make a bad matter worse, it was attempted to use the earth excavated from the tunnel for filling in between the brick arch and the segment timbering. The material was rammed in with all possible care; but when the weight of the material overhead came on the arch, the sides bulged out and the top was flattened, until it was in some places from one to two feet below its proper level.

Evidently this would not do at all, and this system of timbering was therefore abandoned. The system of timbering adopted was the modified English bar method, the bars being bricked in instead of drawn forward. The timbering is supported in bad ground on a 22 × 22 in. oak sill, the ends of which rest on the completed side walls in the bottom drifts, while the portion of its length between the drifts rests on the earth bench. It should be noted that the use of the earth center-core to support the timbering in this tunnel is altogether different from the ordinary use of the center-core in which the tunnel is advanced by a single top heading, and ditches are dug down at each side in which the side walls are built. The defect of the center-core or German system of timbering as commonly used is that the center-core is unsupported at the sides and forms an unsafe and yielding foundation for the timbers which support the roof. But at the Howard St. tunnel the two bottom side drifts, driven in advance, firmly support the earth center-core, and make it a safe foundation for the timbering. The side-drifts also drain the top excavation, permit the building and hardening of the side walls in advance of the arch, and increase the rate of progress at least one-third. This method of working, with two bottom drifts in which the side walls are built, is believed to be used here for the first time. It was devised by Mr. E. J. Farrell, General Manager for the contractors.

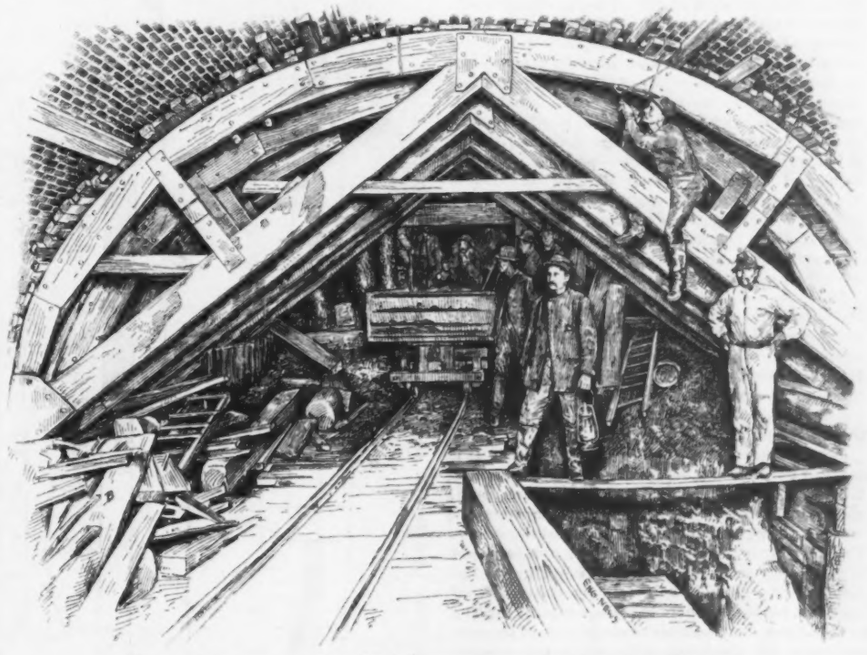


FIG. 9 INTERIOR OF HOWARD ST. TUNNEL, BALTIMORE BELT RAILROAD.

(From a flashlight photograph.)

It is of interest to note that bar timbering was used in the Union and the Baltimore & Potomac tunnels, driven in Baltimore through very similar material twenty years ago.

In starting this system of timbering it was necessary to rebuild part of the work already completed by the segment timbering system, bringing it up to the proper height. Figs. 4 and 5 show the manner in which this was done by the use of poling boards and collars, supported on props.

This piece of difficult work was successfully accomplished, and this and the other headings were then advanced by the methods illustrated in the remaining drawings of our inset sheet. The top heading is first driven by poling boards and collars supported by posts, as shown in Fig. 6. When this has been worked ahead about 20 ft., the two central roof bars are put in to support the collars in place of the posts. This small heading is then gradually enlarged by working toward each side with the poling boards. Fig. 6 shows the manner of working to insert the fourth and fifth bars; and Fig. 7 shows the heading enlarged to the full size, with all the bars and other timbering in place. The bars are of oak, 10 to 20 ins. in diameter

and 20 to 24 ft. long. The masonry lining is built in 18 ft. sections over either wooden or iron centers. Fig. 8 shows the construction of the wooden centers; and Fig. 9, which is reproduced from a photograph taken in the tunnel by a flash light, shows the method of fastening together the pieces of the wooden centering with iron joint plates.

After the excavation is completed for 18 ft. in advance of the finished arch, the centers are moved ahead to proper position and their feet are blocked up on the roof timbers of the side drift, which are given extra support by props from below. The lagging is then put in place and the brick arch is built, the props which support the roof bars being knocked out of the way as fast as the brick arch comes up. In laying the brickwork, 5 to 8 men work together on an 18-ft. section, and about 22 two-shift days work are required per section.

The space between the top of the arch and the lagging and roof bars was at first filled with rubble masonry laid in cement mortar. It was found, however, that the mortar did not have time to set before the centers were struck and the arch received its full load. The result was that the arch bulged out at the sides and sunk at the crown, of course cracking badly in the process. In some places where the pressure was most severe the roof bars were forced down on top of the arch and partially crushed into it, so that on the under side of the arch the location of every roof bar above could be seen. Earth packing was tried, with the still worse results detailed above. At the suggestion of Mr. A. R. T. LACKIE, Resident Engineer, dry rubble packing was then tried, and in this way the settling of the crown of the arch on striking the centers was materially decreased. Of course, some mortar is used with small stone in filling chinks; but wherever the ground requires especial care, the endeavor is to make the dry rubble give a solid support to the arch.

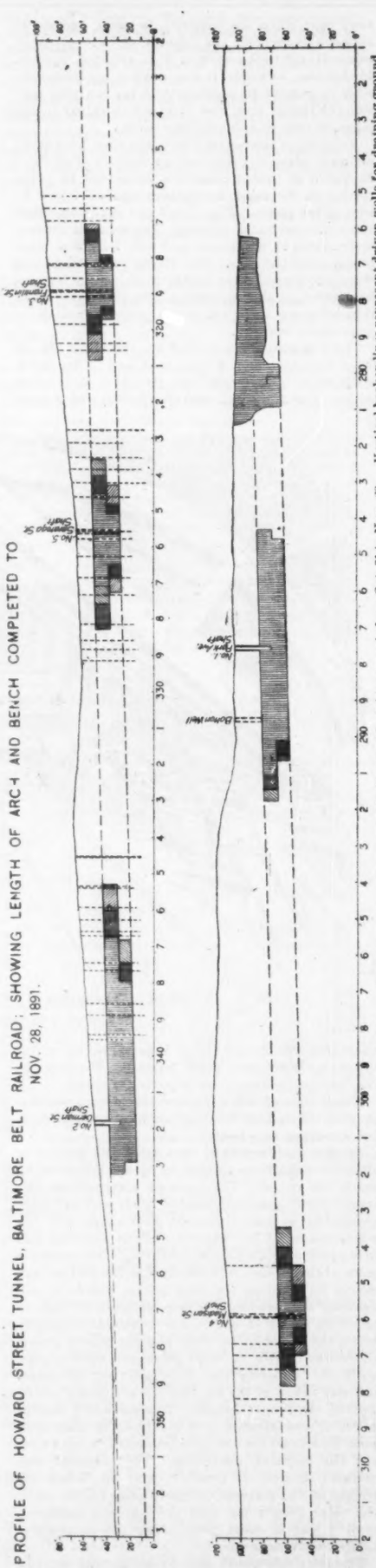
The earth bench is of much convenience in laying the brickwork, rather than otherwise; for the brick and other material is brought in on the upper level, convenient to the work, as shown in Fig. 12. This bench is kept 50 to 75 ft. behind the masons, and a traveling elevator derrick, shown in Fig. 12, hoists the brick cars and other material from the track on the lower level to the bench track.

Figs. 10 and 11 show the iron centering used. It is made of two 6 × 6 in. angle irons bolted together to form a T section. Six of these are used, spaced 4 ft. apart on centers. The centers are made in halves, and bolted together at the crown. The use of a ring bolt permits spacing rods to be put in to hold the arches erect, as shown in Fig. 11. The rear center, which is held fast by the completed masonry, holds the others in place while the lagging is being put on. Another convenience of the iron centers is the readiness with which the mason's scaffolds are put up, being supported from bolt-holes in the angle-irons.

The arch is built of five rings of Baltimore brick well bonded. For a short distance, through the very heavy ground referred to above, eight rings were used. The mortar used is made with one part of New York Rosendale cement to two parts of sand. The cement is tested regularly by the engineering staff. The bond of the side walls and of the arch is shown on the drawings. Refuge niches are left in the side wall, as shown in Fig. 12. They are 15 ins. deep, 3 ft. wide and 7 ft. high.

The progress made on the work up to Nov. 28 is shown graphically on the accompanying profile The rate of progress at each heading on the building of the arch and on the excavation of the bench to complete the tunnel is shown for two four-week periods, from Oct. 3 to Oct. 31 and from Oct. 31 to Nov. 28. The side walls are built, as a rule, not more than 20 ft. in advance of the arch, but in some cases they have been pushed 50 to 90 ft. ahead. The bottom drifts are generally very little in advance of the side walls, the intention being to follow the rule of keeping the masonry lining close to the working face, the wisdom of which, when tunneling through heavy ground, no one will question. The total length of tunnel now arched is about 2,500 ft. About 10 months will be required to complete its longest section, that between shafts 1 and 4. The remainder of the tunnel is expected to be practically complete in about six months. The cost of the tunnel, ready for the track, is about $225 per lin. ft.

The work on the tunnel has been greatly facilitated



PROFILE OF HOWARD STREET TUNNEL, BALTIMORE BELT RAILROAD; SHOWING LENGTH OF ARCH AND BENCH COMPLETED TO NOV. 28, 1891.

Vertical hatching indicates work done prior to Oct. 3; double diagonal hatching, work done Oct. 3 to Oct. 31; single diagonal hatching, work done Oct. 31 to Nov. 28. Vertical-broken lines represent driven wells for draining ground.

by draining the ground in advance of the headings. Driven wells are put down, as shown on the profile, a pump is set up in the street, and a large quantity of water which would otherwise enter the tunnel is thus conveniently disposed of. For nearly all these wells 6-in. pipes were used. About a week is required to drive a well of this size 60 to 70 ft. deep, four or five men being employed. After the tunnel lining is completed past the well, the pump is moved to new wells farther ahead. The pipe is left in the ground, however, and is convenient for use in making connections for the supply of compressed air to the tunnel.

This system of draining the ground by driven wells was devised by Mr. E. J. FARRELL, and is believed to have been used here for the first time in connection with tunnel works.

As we have already noted, in the work of excavating and timbering every effort is made to avoid taking out material outside the line of the tunnel, and to prevent any settlement of the material overhead. Nevertheless, a certain amount of settling is unavoidable. The supports of the roof bars have to be changed three times, and the timbering compresses considerably in taking up the strain due to the mass of material overhead. Even after the load is transferred to the brick arch, there is compression of the mortar joints sufficient to depress the crown of the arch 2 to 6 ins. All causes combined have caused the surface of the street to settle in some places as much as 18 ins. over the line of the tunnel; but the disturbance has generally been from an inch to a foot, varying, of course, with the amount of water found in the workings and with the character of the ground.

The concrete trench of the cable railway has been cracked in several places; but the movement has not been sufficiently serious to interfere with the regular running of the cars. Cracks have been made in some of the sewers, water and gas pipes, and on one occasion a noticeable amount of gas entered the tunnel. There have been no bad breaks, however, in these pipes, notwithstanding the fact that the street is pretty well filled with them, as shown on Fig. 13 of the inset sheet. The sewers on the street are 2 ft. to 4 ft. in diameter; water mains, 3 ins. to 20 ins.; gas mains, 1½ ins. to 20 ins.

Cracks are repaired as fast as they occur, and in several cases the contractors have rebuilt considerable lengths of new mains. When the tunnel is completed, the street will be brought to its former level and repaved.

Notwithstanding the number of large buildings along the street, it is stated that no foundations have been injured thus far by the tunnel work. Fig. 14 shows an outline of the tunnel section where it passes the Darby building, a candy manufactory 8 to 10 stories high. It will be seen that the foundations of the building are inside a line drawn from the bottom of the tunnel excavation corresponding to the "angle of repose." But it is claimed that where, as in this case, the material above the excavation is free to settle, it will do so before the material at the sides can flow in.

A most serious difficulty in pushing work on the tunnel during the hot weather in the early part of last summer was the excessive heat. Fig. 14 shows an example of the location of boiler vaults close to the tunnel line. At Shaft 2 the temperature rose to 95°; and it was from 75° to 80° in the tunnel generally. Of course working in a damp tunnel at this temperature is much more exhausting than working in the open air; and it was determined to try compressed air for cooling the tunnel. An 18 × 24 in. Ingersoll-Sergeant piston-inlet air-compressor was set up in the engine house at shaft No. 1, and a main was laid from it on the street alongside the curb to a point over the north heading at shaft No. 2, a distance of 5,450 ft. At street crossings the pipe is turned down below the surface.

The pipe is wrought iron, 4 ins. in diameter where it leaves the receiver, reducing to 3 ins. and 2 ins. at points further along the line. Air is taken from this pipe to drive five 16-HP. Ryan & McDonald hoisting engines working underground, and five No. 9 Cameron steam pumps. The exhaust from these engines is all turned into the headings, as shown in Fig. 12, and not only supplies fresh air, but keeps the temperature delightfully cool and comfortable. The exhaust from the pumps which work in the street is piped down some of the old well-

holes to the headings. Besides the exhaust from the pumps and hoists, six of the headings have ¼ in. jets by which the compressed air can escape in the heading when the pump or engine is not running. The arrangement of valves by which either "live" or exhaust air is supplied to this ventilating jet is seen in Fig. 12. The air is furnished at a pressure of about 65 lbs., per sq. in. The boilers at Shaft No. 1, where the compressor is located, use about 4 tons of coal in 24 hours.

The air compressor is of the "straight line," direct-acting type, with water-jacketed air cylinder and heads. The steam cylinder is 18 ins., and the air cylinder 18¼ ins. in diameter with a 24-in. stroke. With 94 revolutions and a piston speed of 376 ft., it will furnish 683 cu. ft. of free air per minute. Its total weight is 20,050 lbs. It was furnished by the Ingersoll-Sergeant Drill Co.

The compressed air works the pumps and engines very satisfactorily, and there has been no trouble from ice in the cylinders or exhaust pipes. Common cylinder oil is used for lubrication.

The tunnel is lit by incandescent electric lights. Current is furnished from low-tension C. & C. dynamos driven by Warfield high-speed engines.

The whole charge of the work has been in the hands of Mr. E. F. FARRELL, who is associated with the firm of Ryan & McDonald in the execution of this work. The original location of the line of the road was made by Mr. A. R. T. LACKIE, who was also resident engineer on construction up to July 1, 1891, under Mr. SAMUEL REA, the Chief Engineer of the Maryland Construction Co., until his resignation in the early part of 1891.

The present engineers of the Maryland Construction Co. are Major RICHARD RANDOLPH, Chief, Mr. JOHN P. BOTT, Principal Assistant, and Mr. RILEY, Resident. The engineer for the contractors is Mr. H. B. REID.

Besides the Howard St. tunnel, work is in progress on a short tunnel at York Road through a similar material, but worked by an entirely different system, a full description of which we shall give in an early issue.

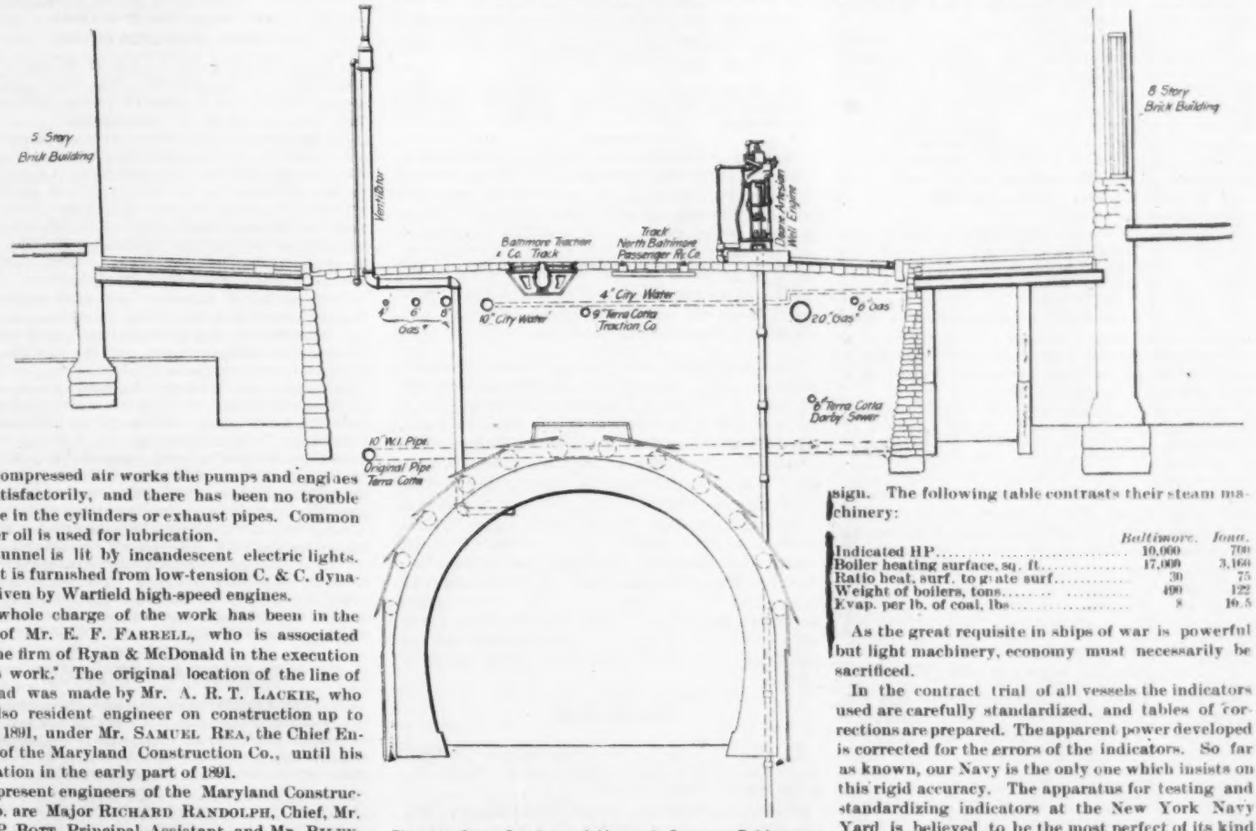


Fig 14. Cross-Section of Howard St. near Baltimore St.; Baltimore Belt Railroad

Report of the Bureau of Steam Engineering.

The most important subject discussed by Chief Engineer GEO. W. MELVILLE, U. S. N., in his annual report, is the imperative need for a large increase in the engineer corps of the Navy. We have been rapidly building modern ships of war, cramming them full of costly and complicated machinery, not only for propulsion, but for handling stores, coal and ammunition, for heating and lighting the vessel and for working her armament. But while this has been going on, Congress has paid no attention to the repeated warnings from the Navy Department that a sufficient force of properly trained engineers must be provided to operate and care for the machinery of the new vessels. The result is that at the present time engineer officers of the Navy are breaking down from overwork or resigning to escape it. The nervous strain of the multitudinous duties which devolve upon them, with the knowledge that some of the duties which they must neglect for lack of time to attend to them may result in disaster, is a great load for conscientious officers to carry.

One result of the scant force of engineers has been the withdrawal of many of the officers detailed to give instruction in technical schools, in accordance with the Act of 1879. Many of the poorer technical schools in the newer parts of the country have felt severely the loss of this aid from the Government.

A bill which failed of passage in the last Congress provided for the enlargement of the engineer corps by the appointment of graduates from technical schools as well as from Annapolis. The course in engineering at Annapolis is short and unsatisfactory. It should be increased to two years and the students should have the spur of competition with graduates of other technical schools to incite them to do their best.

The lack of good mechanics and competent firemen is only less serious than the lack of engineer officers. Some good, however, has resulted from previous complaints on this topic. The *Miantonomoh* has been proposed as a training ship for men of the engineers' force and a course of instruction will begin as soon as she is put in commission.

CONTRACT TRIALS OF NEW VESSELS.

The *Concord*, *Bennington* and *Newark* have each had 4 hour trials under forced draft since the last report, and have proved satisfactory. The first two vessels are duplicates and are identical with the *Yorktown*, save that the forced draft is on the closed ash pit system instead of the closed fireroom. The greater comfort and feeling of security secured by the change are very marked.

A recent change in practice is the substitution of simple non-condensing engines for driving air, feed and circulating pumps, blowers, &c., in place of the high speed compound engines formerly employed. The actual power developed by the auxiliaries is so small that the saving in fuel is not thought to be worth the greater complication and bulk of the more economical engine. In future ships, however, it is intended to have the auxiliary engines exhaust into the intermediate receiver of the main engines, thus gaining economy without losing in efficiency.

In these trials the coal used was carefully measured, and it is believed that the results obtained form the first reliable statement of fuel economy with full power forced draft that has ever been published. The fuel consumption per I.HP. per hour was 2.434 lbs. for the *Newark*, 2.76 lbs. for the *Concord*, and 2.60 lbs. for the *Baltimore*. These figures show that the common estimates of coal endurance are entirely too low, and the radii of action predicated therefrom are entirely too high.

The Navy Department is sometimes criticised because its steam machinery is not as economical as that on merchant vessels. While this is truly the case, yet it shows no fault in the naval machinery. The war vessel has a hull filled with powerful machinery, the merchantman has only enough engine and boiler power to propel her at an economical speed. As an example of this, take the U. S. S. *Baltimore* and a merchant steamer called the *Iona*, each of about the same displacement (4,450 tons), and both of them considered of the best English design. The following table contrasts their steam machinery:

	Baltimore.	*Iona.*
Indicated HP.	10,000	700
Boiler heating surface, sq. ft.	17,000	3,160
Ratio heat. surf. to grate surf.	30	75
Weight of boilers, tons.	499	122
Evap. per lb. of coal, lbs.	8	10.5

As the great requisite in ships of war is powerful but light machinery, economy must necessarily be sacrificed.

In the contract trial of all vessels the indicators used are carefully standardized, and tables of corrections are prepared. The apparent power developed is corrected for the errors of the indicators. So far as known, our Navy is the only one which insists on this rigid accuracy. The apparatus for testing and standardizing indicators at the New York Navy Yard is believed to be the most perfect of its kind in existence. The indicators are tested under steam pressure which is measured directly by a column of mercury to which all possible corrections are applied. The apparatus has been so perfected that it is only necessary to attach the instrument, regulate the steam pressure, and push a button; the pencil is pressed against the paper, and the drum is revolved by electricity.

STEEL CASTINGS.

The department continues to have the most discouraging experience with cast steel, and forged or rolled steel or cast-iron has had to be largely substituted in its place. In some cases the castings have been re-enforced with steel plates, and in others they have been made abnormally heavy and machined to size. The makers of steel castings admit that many failures have occurred, but claim that the designs for machinery call for shapes that cannot be successfully cast in steel. They say that if they were permitted to modify the shapes and split up the casting as into many parts as they desired, they could guarantee good work. Without exception, the steel makers have been met in friendly spirit by the Bureau, and every reasonable change which they have suggested has been allowed. Chief MELVILLE continues as follows:

But there must, of course, be a limit to this. We do not design machinery for amusement nor to ascertain if steel makers can cast the parts, but to answer certain very definite purposes. If cast steel will fill the requirements

better than any other metal, we desire to use it; but if we are to be hampered by being limited to a few shapes, and having pieces which would be one easy casting in iron cut up into a number, involving expensive machine work to fit together, and the uncertainty of bolted joints in the very places where simplicity and solidity are most needed then the conclusion cannot be avoided that steel castings are not desirable for such purposes.

It is interesting to compare the attitude now taken by the steel makers with that assumed by them some seven or eight years since, when the first of our new vessels were building. They claimed then that they could cast anything in steel that could be cast in iron, and the Advisory Board (which was then responsible for the general designs of the ships and machinery) was criticized for its unwillingness to accept these statements without question, and use steel castings for all parts of machinery. When it was found that a fair degree of success had been attained in steel casting, they were taken at their word and given opportunity to show their capacity, and now they claim that the shapes called for (which are neither intricate nor new) cannot be cast.

It cannot be too plainly stated nor too strongly emphasized that the only reason for using cast-steel instead of cast-iron is that advantage may be taken of its greater strength to reduce weights. There can be no greater absurdity than to make steel castings of the same size as those of cast iron with a view to greater safety if the strength of the iron casting is ample; steel castings cost four or five times as much as iron ones, and it would be a deliberate waste of public money to use material in this way. The same is true of the plan of making pieces of several parts bolted together.

The little progress made in the production of steel castings was proved in a marked degree with the engine columns of a certain ship. These were perfectly plain hollow columns, and in cast iron would have been the simplest kind of work; in cast steel every one was so imperfect that they could not be used. After the failure of these columns, the steel makers claimed that they were of a shape impossible to cast in steel; but before the castings were found defective not one of the makers thought there would be the least trouble in making them.

I am loth to believe that we shall be obliged to permanently abandon steel castings; for if the processes of manufacture can be improved so that absolute reliance can be placed on the product, the question of light machinery for war vessels is rendered much easier of solution. Moreover, it has always been found possible in other promising lines of work to ascertain the causes of first failures and to remedy them, and I am inclined to believe that in time this will be done for steel castings, since one firm has already successfully produced forms that the other makers said could not be cast, and their manager has stated that it is simply a question of time and the education of superintendents and workmen before we can safely count on the production in cast steel of any form now made in cast iron.

CONDITION OF THE NAVY YARDS.

The great defect in all the navy yards is the almost total absence of appliances for lifting and transporting heavy weights economically and quickly. Many shops are so designed and constructed that overhead traveling cranes cannot be placed in them, and recourse is had to swinging pillar cranes and hand trucks. Locomotive steam cranes would be almost as useful as overhead cranes, but there is not one under control of the bureau. Contracts have been let, however, for one locomotive crane and three overhead electric cranes for the New York navy yard. An electric welding plant and a hydraulic riveter with 126 ins. gap are also to be put in. It is recommended that $20,000 be expended for a testing machine of at least 600 tons capacity to be located at this yard. Also that the same amount be expended for a hydraulic bending press.

At the Boston and the League Island navy yards about all the work done is to keep the shop machinery in repair. It is urgently recommended that both these yards be placed in proper condition for the construction and repair of ships. The Norfolk yard is well equipped for ship building, but not for engine and boiler work. About $50,000 would be required to put the yard in shape for economical boiler construction.

VARIOUS TESTS.

During the year evaporative tests were made on the Thornycroft boiler of the torpedo boat *Cushing* and on the Towne launch boiler. There were also progressive horse power trials of the *Cushing* and some tests of the strength of manganese bronze. The report of the *Cushing* trials we shall abstract in another issue. The manganese bronze was cut from a propeller made by B. H. Cramp & Co., of Philadelphia. The average of a large number of tests was as follows: Tensile strength 38,324 lbs., with 6.3% elongation and 11.80% reduction of area. Compressive strength, 156,733 lbs.; total compression, 36.6%.

The Towne boiler tested was of the tubulous type; and it weighed complete, with smokepipe, 1,100 lbs. Filled with water to working weight, it weighed 1,400 lbs. Under a forced draft of a little over 1 in. of water, an evaporation of 5.8 to 6.8 lbs. of water per lb. of coal, from and at 212°, was obtained. Under natural draft about 7.55 lbs. was the record. The steam was the driest when working under forced draft. The hourly rate of evaporation from and at 212° per sq. ft. of heating surface was 1.79 to 2.65 lbs. with natural draft, and 7.87 to 9.69 lbs. with forced draft. When worked hardest the boiler used per hour 104.56 lbs. of coal and evaporated 525 lbs. of water. Under natural draft with semi-bituminous coal the average hourly consumption of coal was 14.44 lbs., and 98.75 lbs. of water was evaporated.

BREADSTUFF EXPORTS show the following remarkable increase over last year, as an effect of the short crops in Europe and large crop here:

	1890.	1891.
Month of November	$7,682,004	$24,588,979
Five mos. ending with November.	44,670,477	125,747,300
Eleven mos. " "	126,719,163	191,077,607

THE DRAINAGE OF THE CITY OF CAIRO is to be undertaken by the government of Egypt. Propositions for the work, accompanied by the necessary plans and documents will be received by Mr. COLIN SCOTT MONCRIEFF, Under Secretary of State, Ministry of Public Works, Cairo, Egypt, until Jan. 31, 1892. A premium of $1,000 will be granted to the author of the proposition selected, but the government does not hold itself bound to accept any, should it not consider them suitable.

THE HOLZAPFEL METHOD OF VESSEL CONSTRUCTION has been adopted in a steel barge launched Nov. 16 at Wallsend, England. The vessel was 72 ft. in length, with 19 ft. 6 ins. beam and 7 ft. depth. The Holzapfel system consists in flanging the plates on all four sides before placing them in position, and then punching the flanges and riveting them together with portable hydraulic machinery. The plates are 2 ft. wide and have 4½ in. flanges. Tube rivets were used to give drainage from the various cells formed by the flanged plates in the bottom, and the cells were then cemented level with the bottom of the tube rivets. The great advantages claimed for the system are the doing away with all hand riveting on the ship plates, and the punching of all the rivet-holes with the plates in place.

PERSONALS.

Mr. FRANK WENTER has been elected President of the Board of Drainage Commissioners, of Chicago, Ill., in place of Mr. PRENDERGAST.

Mr. WM. HAM HALL, Consulting Engineer, San Francisco, Cal., has removed his office to the New Mercantile Library Building in that city.

Mr. C. A. MERRIAM, Assistant Manager and Chief Engineer of the Monterey & Mexican Gulf R. R., will assume the duties of General Superintendent, vice Mr. JOHN GRACE, resigned.

Capt. WM. H. BIXBY, U. S. Corps of Engineers, has been transferred from Wilmington, N. C., to Newport, R. I., to succeed Major LIVERMORE, of the same corps, in charge of river and harbor work.

Mr. G. A. A. DEANE has been appointed Land Commissioner of the St. Louis, Iron Mountain & Southern Ry., in charge of lands in Arkansas, with headquarters at Little Rock, Ark., vice Mr. THOMAS ESSEX, resigned.

Mr. M. J. CARPENTER, Vice-President of the Duluth & Iron Range R. R. has been appointed President, vice Mr. H. R. BISHOP, resigned. Mr. C. W. HILIARD Secretary and Treasurer, will succeed Mr. CARPENTER as Vice President.

Mr. JOHN T. BURNS, Superintendent of Transportation of the Denver & Rio Grande R. R., has been appointed Superintendent of the First Division of that road, vice Mr. A. W. DEUEL, resigned to take the position of Superintendent of the Gulf Division of the Union Pacific Ry.

Mr. WM. G. HAMILTON, inventor of the Hamilton steeled wheel largely used on the Pennsylvania and other roads, and a consulting engineer of that road, was badly injured in the back by the accident to a vestibule express at Lima, O., chronicled elsewhere, caused by the splitting of the train on a broken switch. His son, WM. V. HAMILTON, had his left foot crushed in the same accident. Mr. HAMILTON has been for years a prominent member of the American Society of Civil Engineers, and lately gave $1,000 to its building fund. It is expected that he will recover from this accident, though it is as yet too soon to say how severe was the shock to his system.

Col. WILLIAM E. MERRILL, U. S. Engineer in charge of the Ohio River and its navigable tributaries, dropped dead Dec. 14 on an Ohio & Mississippi train near Edgefield, Ill., while going to Shawneetown on business. Colonel MERRILL was born in Wisconsin in 1825, graduated from West Point in 1859, and entered the army engineer corps. He served through the war with distinction. He was made Major in the Corps of Engineers, 1867, and Lieutenant-Colonel, same corps, 1883. He assisted in many engineering works of importance during the war, and in 1878 was sent by the Government to Europe to gather information on the construction of movable dams. He served on numerous boards as an expert, and was the author of "Iron Truss Bridges for Railroads" and "Improvement of Non-Tidal Rivers."

NEW PUBLICATIONS.

—*Annual Report of the Chief of the Bureau of Steam Engineering*, for the year 1891. GEO. W. MELVILLE, Engineer in-Chief, U. S. N., Chief of Bureau. Washington, 1891. Pub. doc., pp. 83. 12 folding plates.

The first glance at this report gives one a very favorable impression as to the work which is being done in the Navy Department these days, or at least in this especial bureau. It is not often that the reports of government departments are sent out bearing the date of the current year; but this pamphlet is dated Oct. 12, 1891, and submits estimates for the fiscal year ending June 30, 1893. The report contains much matter of engineering interest, the most important of which we abstract elsewhere.

—*Ohio Society of Surveyors and Civil Engineers.*—Transactions of the Society at its Twelfth Annual Meeting, Columbus O., Jan. 20, 21, 22, 1891. E. D. Wileman, Secretary, Massilon, O Paper, 9 x 6 ins.; pp. 163. Price, 50 cts., with 5 cts. for postage.

This volume contains the reports of officers and reports of committees on "Legislation," "Civil Engineering," "Land Surveying," "Highways" and "Blanks and Instruments." It also contains the following papers: "Railway Surveying in South Australia," E. D Wileman; "Construction of the Louisville Southern R. R.," S. F. Rock; "Knowledge of the Practice of Surveying and Engineering," C. N. Brown; "Land Surveying," G. S. Innis; "Transit Points, "J. L. Culley; "Separate System of Sewers for Dayton, O.," F. J. Cellarius; "Construction of Sewers," C. A. Judson; "Separate System of Sewers," J. B. Weddell; "Permanent Drainage," D. W. Seitz; "Domestic Water Supplies," J. B. Strawn; "Brick Paving," E. B. Shifley; "Substructure for Bridges," W. K. Liggett; "Measure," D. W. Pampel.

SOCIETY PROCEEDINGS.

American Forestry Association.—The next meeting will be held at Washington, D. C., Dec. 29 and 30 One of the special subjects to be considered is the securing of national forest reservations, a memorial in regard to which will be presented to President Harrison.

New England Water-Works Association.—At the quarterly meeting at Boston, Dec. 15, a paper on "Selection of Sources of Water Supply," was read by Mr. F. P. Stearns, Chief Engineer of the Massachusetts State Board of Health.

Iowa Civil Engineers' and Surveyors' Society.—The fourth annual meeting will be held at Burlington, Ia., Dec. 29. Reports of committees and the following papers will be presented: "Permanent Reference Marks for Surveys," C. W. Bisbee; "Clay for Fire Brick, Wm. Steyh; "Coal Mines," B. H. Johnston; "Changes in the Code," L. Higgins; "Truss Bridges," E. M. Gilchrist; "Cost of Earthwork," J. N. Brown; "Tide Lands," A. B. Little; "Title by Adverse Possession," Seth Dean.

Civil Engineers' Club of Cleveland, O.—At the meeting on Dec. 8. Prof. C. S. Howe read a paper on "Mathematical Tables and Methods of Calculation," and Mr. N. P. Bowler read one on "Patents and the Patent Office of the United States." A discussion, led by Professor Stockwell, followed Professor Howe's paper. Mr. Bowler's paper was devoted to a consideration of the patents issued during the first 50 years of the nation's history.

Liverpool Engineering Society.—The third meeting of the session was held Nov. 25. Mr. John T. Wood, President, in the chair. The evening was devoted to the discussion of some questions of practical engineering interest. A question introduced by Mr. George Farren dealt with the silting up of a small harbor in Carnarvonshire, and the methods adopted to prevent this silting up. Mr. A. W. Brightmore submitted some novel methods of land dredging and protecting slopes on river work in Holland. Mr. J. H. T. Turner introduced some questions in connection with rain gaging and the action of a sewer siphon.

Civil Engineer's Society of St. Paul.—A joint meet-

ing of this society and the Minneapolis Engineer's Club was held at St. Paul Dec. 7.

Prof. W. R. Hong, of Minneapolis, read a paper on "Geodetic Leveling," explaining in detail the instruments employed in precise leveling, their adjustments and use. He stated that a precision of 1 to 1,000,000, common in horizontal, is not possible in vertical measurements; mm. into the square root of the number of kilometers run is precise for leveling, but 5 mm. $\sqrt{km}$ is hardly possable. A portable turning point is used, the rod resting in a shallow cavity thereon and held as nearly plumb as practice enables a rodman to hold it. Readings are taken to $\frac{1}{10}$ of a millimetre.

Engineering Association of the South.—The regular meeting was held at Nashville, Tenn., Dec. 10. Mr. Hunter McDonald, of Atlanta, Ga., engineer in charge of the Western Atlantic R. R., presided. The Secretary presented the specifications governing the competition for the cash prize of $1,000 offered by the Board of Public Works of Duluth, Minn., for the best plans for a drawbridge across the ship canal at that place.

Mr. Olin H. Landreth brought up the question of instituting under the auspices of the Association a competitive trial of machinery used in highway building, such as graders, ditchers, surfacers, rock crushers, steam and horse rollers, etc., and after an extended discussion a committee was appointed to investigate and report at the next regular meeting the feasibility of instituting such trials. Messrs. Olin H. Landreth, W. G. Kirkpatrick and J. A. Fairleigh comprised the committee.

The paper of the evening was on "Refrigerating Systems," by Dr. Wm. L. Dudley, of Vanderbilt University, Nashville. It comprised an historical account of the development of refrigerating methods, and after classifying the several processes under the head of "absorption" and "evaporating" systems, proceeded to develop a comparative exhibit of the chemical and mechanical results obtained by each process. The paper was illustrated by diagrams showing the working of the different systems, as well as lithographs and photographs of modern machinery as now built. In the discussion which followed Mr. W. C. Kirkpatrick suggested that the cooling effect of expansion of compressed air might be utilized both to cool and aerate the water of cisterns in summer by a portable air compressing apparatus with coils for cooling the compressed air. In many sections of the South roof water preserved in underground cisterns is the chief dependence for domestic supply, and the proposed method of cooling and aerating and thus rendering the conditions unfavorable for development of disagreeable taste and odor was referred to. The low thermal conductivity of the soil surrounding cisterns is a favorable circumstance to the permanence of the effect of such cooling.

American Society of Civil Engineers.—At the meeting on Dec. 16, the President, Mr. Octave Chanute, in the chair, Mr. Fteley, acting as Secretary, announced the deaths of C l. Wm. E. Merrill, U. S. Engineer Corps, and Mr. John Lockwood.

A paper on "The Red Rock Cantilever Bridge," by S. M. Rowe, S. W. Robinson and H H. Quimby, was read in abstract, but the paper being lengthy the reading lasted until 9 P. M. which is the time when, under present arrangements, the second meeting of the month is adjourned, to allow more time for social conversation. Mr. Macdonald and other members referred to the disadvantages of this system, as well as of having to spend so much time in listening to the reading of a paper already printed and after some discussion it was finally voted to postpone the adjournment. Mr. Macdonald in a brief discussion spoke favorably of the use of concrete for piers in locations where there is no danger from frost. Referring to the statement in the paper that considerable material was rejected at the rolling mills on account of surface defects and flaws, he said it was a question whether such ordinary surface defects were really injurious. Tests of such rejected material have shown it to be of excellent quality. Some of the first of the large high-steel plates for the Forth Bridge cracked like glass when unloaded from the cars, but investigation showed that this was due to the effects of shearing, and the defect was obviated by planing off about 1¼ ins. of the edges. What is wanted in bridge construction is a "commercial" and not a "laboratory" steel. Mr. Macdonald also spoke in favor of combining constructional strength with artistic outline in bridge design.

The Red Rock cantilever bridge carries the Atlantic & Pacific Ry. across the Colorado River at The Needles, between Arizona and California. It has a span of 660 ft., the cantilever arms being 165 ft. long, and the suspended span 330 ft. The bridge was described and illustrated in ENGINEERING NEWS, Oct. 27 and Nov. 4, 1890.

New England Railroad Club.—At the meeting on Dec. 9 the subject discussed was "Tools and Machinery for Railway Shops." There was general agreement that railway companies as a rule pursued a penny wise and pound foolish policy in the provision of machinery in their shops. Antiquated tools, bought when the road was first opened, are kept in service, and the introduction of modern labor-saving machines is neglected. The managing officials of a railway do not, as a rule, appreciate the needs of the shops, and they consider it wasteful to buy new tools in place of old one swhich may be in good repair and yet be too antiquated in design to work economically.

Mr. E. E. Davis, who opened the discussion, said that planers ought to run 16 ft. to 30 ft. per minute, and lathes to run 25 to 45 ft. per minute with feeds of $\frac{1}{32}$ in. to $\frac{1}{8}$ in. A screw machine is one of the best investments which a railway company can make. It will save 25% to 50% in the cost of work, and will produce it of uniformly good quality. The advantages of the milling machine are not half appreciated by railway shop managers. Some kinds of work can be done 25% cheaper on the milling machine than on the planer and 50% cheaper than on the lathe. The vertical boring and turning mill is another tool which rapidly pays for itself in boring tires, turning wheel centers, &c. The overhead railway with pneumatic hoist has proved to be as much superior to the chain hoist as that was superior to manual labor. In the boiler shop, the reason why railway shops find themselves unable to compete with the manufacturers is the lack of proper tools. Punch and shears, power bending rolls, steam or hydraulic riveter, plate planer and drills, with proper overhead cranes for handling work are all needed to build boilers economically. Proper management of tools is essential, however, to economical work. Mr. Davis said he had seen a man turning off a driving journal at the same speed at which he turned the tire. In another shop a planer 60 × 60 ins. with 12 ft. bed, and running about 14 ft. per minute, is used for planing side-rod brasses.

The advantages of the screw machine and of the pneumatic hoist for shop use were brought out still more plainly by other members.

At the meeting on Jan. 13, the subject for discussion will be "Locomotive Boilers and Their Attachments."

Engineers' Club of Philadelphia.—Meeting of Dec. 5, 1891. The following nominations were made for officers for 1892: President, James Christie; Vice-Presidents, Fred'k H. Lewis, Howard Murphy, Pedro G. Salom; Secretary, John C. Trautwine Jr.; Treasurer, T. Carpenter Smith; Directors, John E. Codman, George V. Cresson, Strickland L. Kneass, Wilfred Lewis, M. Richards Muckle, Jr., H. W. Spangler, David Townsend.

The committee appointed to consider the question of Land-locked Navigation through the bays and inlets of the Atlantic and Gulf coasts, and to communicate with the Board of Trade and other commercial bodies of the eastern and southern seaboard cities, reported favorable resolutions, and a form of letter transmitting the foregoing to the various bodies referred to, to be accompanied by a digest of the route proposed and by copies of such other papers as may be necessary to properly present the subject.

Mr. F. H. Lewis' specifications for bridge superstructure, which were submitted at the meeting of Oct. 17, were discussed.

Mr. Burr believed that the specifications were unnecessarily explicit. The practice of placing stringers on top of the floor beams, the requirement that legs of trestles must be so inclined as to avoid tension on the windward side of the viaduct, and the limiting of the size of steel bars to 8 × 2 ins., were criticised. Mr. Burr, however, commended that portion of Mr. Lewis' specifications which covers the use of steel. His experience had convinced him that the grade of metal called by Mr. Lewis "soft steel" can be properly treated like iron in all the shop manipulations of punching, shearing and riveting.

Mr. Rickett's believed that it was hardly advisable for all railways to insist upon the use of steel for all web plates, or to specify that stringer beds must be of cast iron. He believed also that 9 ft. was an unnecessarily wide spacing for stringers in single track through bridges, and that a spacing of 7 ft. is equally safe; also that for spans between 100 and 120 ft. lattice bridges were as safe, as rigid and as good as pin connected trusses. He questioned the advisability of requiring an increase in the allowance for wind pressure per lineal foot in spans over 200 ft., and believed that a distinction should be made between loaded and unloaded bridges in this respect.

Other features criticised by Mr. Ricketts were the provision for cross ties resting directly on bottom chords; the allowance for the weight of full sized chord compression members in the use of the formulæ for long columns; the compulsory use of equal-legged angles between stringers and floor beams; the clause relating to stiffeners; the requirement that splices in heavy members should break joints with each other; the compulsory use of vertical web members in lattice bridges, and the requirement that bars in double as well as in single latticing must make angles of 60° with the axis of the piece.

Mr. Hunt suggested 60,000 to 68,000 lbs. tensile instead of 70 000 for medium steel, and urged a requirement respecting the appearance of fracture for both medium and soft steel; also the drifting test for both steels. He did not think that a formula modeled after that of the standard bridge builders' specifications should be required to be used by the subordinate officers of manufacturing concerns. The requirement of 18% elongation in 8 ins. is too severe. He should accept ordinary bar iron which stoood 48,000 tensile with 16% elongation, *provided the fracture was fibrous.* Sheet aluminum used in place of sheet lead for bearings has the advantages that it takes a square bearing, does not flow as much as lead and will not oxidize or corrode. Bulk for bulk, the cost of aluminum is now very close to that of lead. He should not reject medium steel for solid rolled beams. In the Pittsburg district the difficulty in producing good iron has been aggravated recently by the irregularity in the supply of nasural gas.

A paper by Mr. Geo. R. Ide on smoke abatement in cities was presented. The principal objections to smoke are that it gives everything in the neighborhood a disagreeably smutty appearance, that it renders the atmosphere unpleasant to breathe, and that it produces injurious effects on vegetation. The loss of fuel is probably not greater than 1%. There are three systems of supplying fuel by hand—the spreading system, the coking system, and the alternate side firing system. A great amount of care is required with any system of hand firing, to prevent the formation of smoke; much more than can usually be exercised. The coking system is as old as 1800, when a patent was granted in England for such a system. In the United States since that time there have been probably 1,000 patents granted for contrivances of this nature. In all or most of these contrivances the principle is old, but embodied in various forms, and many of them are successful in preventing the formation of smoke in objectionable quantities. The principal reason why a more general use is not made of these devices is their first cost, and the fact that some one else is inconvenienced. Few cities have any regulations on the subject, and those that have do not enforce them for fear of driving away manufactures. The report of the Smoke Abatement Committee in 1882 shows that by the use of improved designs of furnaces and methods of operating them the smoke nuisance may be practically done away with, and that the use of mechanical stokers is of the greatest importance in producing this result. The abatement of the smoke nuisance, so far as steam boilers are concerned, does not depend upon the possibility of designing suitable new appliances, but upon that of inducing proprietors to use the appliances long since designed.

Mr. Strong believed that the public was not yet educated up to the conviction that smoke prevention was a possibility. He found that railway managers took little interest in devices for the purpose, however successful, unless forced by competition with non-smoke producing roads. When fire bridge walls are provided with openings in the back these soon become clogged with slag. Air must be supplied under the grate.

Mr. Livingston said every effort had been made in Pittsburg to abate the nuisance, but the trouble always in the way was that smoke prevention cost more than it came to. The proper remedy is first to convert the soft coal into gas and then burn the gas.

Mr. Spangler, for the Committee on Information, called attention to the device used in Chicago & Alton engines, and mentioned an inventor who tried the plan of fanning the smoke back into and through the fire.

Mr. Baltz referred to the residences on "the bluff" in West Philadelphia, where the smoke from the Pennsylvania R. R. locomotives passing around the bluff immediately under the houses, comes in the cellar windows and into the hot air flues of the furnaces and is thus introduced into every part of the house.

Mr. Kerr said that mechanical stokers may, if desired, be so manipulated as to prevent the emission of smoke. Referring to Chicago, he said the difficulty there lay in the low setting of the boilers put up in past years, and the consequent difficulty in introducing sufficient air below the grates, the water in the ground preventing the introduction of proper air ducts below the boilers; but if there is anything that popular feeling can do in the premises it will be done in Chicago between this and 1893. The successful devices depend upon the supply of a great surplus of air, which of course means mere dilution of the smoke and must be accompanied by a loss of efficiency, and this has brought smoke consuming devices, as a class, into disrepute.

Mr. Smith had had some experience with mechanical stokers, of the continuous chain grate pattern. They reduced the smoke, but were found costly in repairs and were abandoned. He referred to the use of deep copper fireboxes and of fire bridges on English and Scotch locomotives.

Mr. Kerr remarked that such devices were useful on locomotives, but could not be applied to stationary engines. In locomotives the bridge reduces the excess of draft. In stationary engines there is a deficiency of draft to start with.

Mr. Morris referred to the work of Charles Y. Williams, published in 1842, as containing pretty much all that is known to day on the subject, and which summed up the matter in the conclusion that smoke prevention does not pay.

The Secretary read a paper by "an Ex-Member of the House Committee," dealing with the problem of suppressing or mitigating the emission of smoke during the meetings to the annoyance of some of those who failed to contribute their quota to the club output. It was noted that upon submitting the question to vote upon a previous occasion the verdict was 101 to 100 against prevention.

JOHN C. TRAUTWINE, JR., Secretary.

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AND

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GEO. H. FROST.....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

Montana Society of Civil Engineers.—Dec. 19. Helena.
Engineers' Club of Philadelphia.—Dec. 19. House, 1122 Girard St., Secy., H. Murphy.
Iowa Civil Engineers and Surveyors Society.—Annual meeting at Burlington, Dec. 29. Secy., Seth Dean, Glenwood.
American Forestry Association.—Next meeting at Washington, D. C., Dec. 29, 30. Secy., Dr. Fisher, Philadelphia, Pa.
Technical Society of the Pacific Coast.—Jan. 1. Secy., O. von Geldern, 319 Market St., San Francisco.
Swedish Engineers' Club.—Jan. 2. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
Northwest Railroad Club.—Jan. 2. Rooms, Union Station, St. Paul.
Civil Engineers' Society of St. Paul.—Jan. 4. Secy., C. L. Annan.
Engineers' Club of Kansas City.—Jan. 4. Rooms, Baird Building. Secy., H. Goldmark.
Western Society of Engineers.—Jan. 6. Secy., J. W. Weston, 230 La Salle St., Chicago.
Engineers' Club of St. Louis.—Jan. 6. Secy., Arthur Thatcher, Odd Fellows' Building.
American Society of Civil Engineers.—Jan. 6. Secy., Francis Collingwood, 127 East 23d St., New York.
Engineers' Club of Minneapolis.—Jan. 7. Rooms, Public Library Bldg. Secy., F. W. Cappelen.
Association of Civil Engineers of Dallas.—Jan. 8. Secy., E. K. Smoot, 808 Commerce St.
Civil Engineers' Club of Cleveland.—Jan. 8. Secy., A. H. Porter, 50 Euclid Ave.
Atlanta Society of Civil Engineers.—Jan. 12. Secy., Parker N. Black, Capitol Block.
Denver Society of Civil Engineers.—Jan. 12. Secy., Geo. H. Angell.
Northwestern Society of Engineers.—Jan. 12. Rooms, Occidental Block, Seattle. Secy., E. H. Warner.
Civil Engineers' Association of Kansas.—Jan. 13. Secy., I. C. Herring, Wichita, Kan.
New England Railroad Club.—Next meeting, Jan. 13. At United States Hotel, Boston. Secy., F. M. Curtis.
Engineering Association of the Southwest.—Jan. 14. Secy., O. H. Landreth, Nashville, Tenn.
Northwestern Track and Bridge Association.—Jan. 15. Rooms, Union Station, St. Paul.
Western Railway Club.—Jan. 19. Rooms, Rookery Building, Chicago. Secy., W. H. Marshall.
Engineers' Society of Western Pennsylvania.—Jan. 19. Secy., J. H. Harlow, Pittsburg, Pa.
Boston Society of Civil Engineers.—Jan. 20. Secy., S. E. Tinkham, City Hall.
Canadian Society of Civil Engineers.—Jan. 21. Secy., H. T. Bovey, 112 Mansfield St., Montreal, P. Q.
Engineers' Club of Cincinnati.—Jan. 21. Secy., J. F. Wilson.
New York Railroad Club.—Jan. 21. Rooms, Gilsey House.
Scandinavian Engineering Society of Chicago.—Jan. 21. Secy., T. G. Philfeldt, 113 Adams St.
Southern and Southwestern Railway Club.—At Atlanta, Ga., Jan. 21. Secy., F. A. Charpiot, Macon, Ga.

IMPORTANT TO SUBSCRIBERS.

Hereafter we will not accept a subscription to this journal from subscription agents or from anybody else at less than our published rates. No club rate or commission will be allowed. Newsdealers and agents must send their orders to their News Company. This policy is one of necessity. We spare neither money nor labor in the effort to produce the very best of engineering newspapers and in justice to ourselves and to all of our subscribers we must have our full rate every time.

We shall be obliged if subscribers will deal with us direct, and it will be a favor also if they will use a printed letter-head or inclose a professional card for classification purposes; it will be of advantage to them also.

ENGINEERING NEWS PUBLISHING CO.,
Tribune Building,
July 4, 1891. *New York.*

IF any one doubts that a large gain in fuel economy can be made by the use of compound locomotives in place of those of the ordinary type, we suggest that a careful and unprejudiced examination be made of the records of experiments on this subject published in our last two issues. The stock arguments against the use of compound locomotives have been first that their showing of increased fuel economy was chiefly due to better management on the part of the engine crew; second, that they could not start or pull such long trains up such heavy grades as the simple locomotives: third, that the cost of repairs and the interest on the increased first cost were sufficient to absorb the bulk of the saving in fuel anyway.

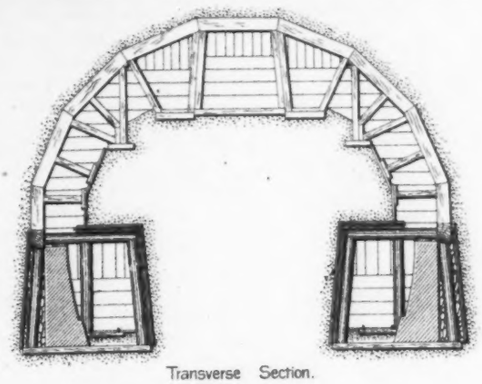
All these objections are fully met in the reports of the eleven months' trial on the East Tennessee, Virginia & Georgia, given in our issue of Dec. 5, and the extended series of trials on two New England railways given last week. In the face of these records it is difficult to see on what the ultra conservative element which has opposed the compound locomotive can base their arguments. It is also difficult to see what valid excuse a superintendent of motive power can have for delaying action in introducing the compound on his road. The able committee of the Master Mechanics' Association which reported on this subject in 1890 only allowed a saving in fuel of 17 per cent. by the use of the compound. But the ten months tests on the East Tennessee, Virginia & Georgia showed a saving of 25 per cent., and this is close to the average shown in all the careful tests of fuel economy which have been reported. To show the importance of this saving, on roads where coal is expensive, take the Southern Pacific system, which in 1889 spent $5,020,724 for locomotive fuel. If 25 per cent. of this were saved, the gain would be $1,255,181, which is over 8 per cent. of the net earnings of the whole system in that year.

WE give up an unusually large amount of our space this week to an article on the candle-power efficiencies of all the various systems of car lighting now in use, including oil lamps, compressed oil gas, gasoline gas, electric incandescent lamps and (for comparative purposes only) electric arc lights. The material was of such nature that it could not well be divided between two issues and as the record given is the first of the kind ever made, the space seemed well bestowed. It would seem as if the fundamental inquiry in considering any new lighting system should be, How much light does it give as compared with other systems? But as a matter of fact hardly any of our railways have made photometric tests of their lamps; and those which have, like the Erie and Milwaukee & St. Paul have tested them only in a horizontal plane. To judge of the efficiency of modern car lighting plant, however, it is absolutely necessary to measure the candle-power at frequent intervals in a circular arc, for reasons given more fully elsewhere; and this work was very ably and carefully done for us by Mr. W. B. D. PENNIMAN, chemist of the Baltimore & Ohio Railroad, with the co-operation of the owners of the several systems tested, but under his sole control. Heretofore such records have only been obtainable from the owners of such systems, and we may add, from only one of these systems (the compressed oil gas plant); the owners of other systems, though making very positive and liberal claims as to the candle-powers obtained, never having made any actual candle-power tests, either in their own shops or in the shops of the railways which were introducing their plant.

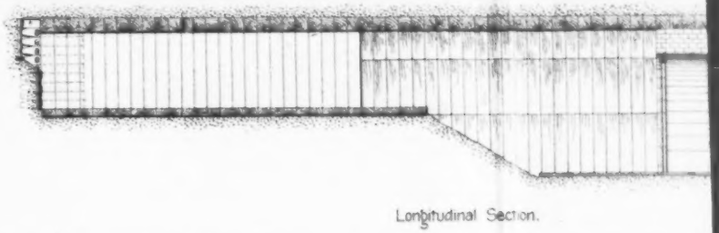
EVEN after candle-power tests of this kind have been made, however, they do not furnish a fair or an adequate measure of the absolute quantity of *useful* light obtainable from the various illuminants as actually used in the car. To do this properly we have been obliged to devise a new unit, which we have christened a VISUAL UNIT. This unit though directly deducible from the candle-power records is yet quite different therefrom. It shows the absolute quantity of *effective* light (in candle powers at a distance of 4.5 ft.) which falls perpendicularly upon a book or newspaper held in the usual way by a seated passenger. From the diagrams showing these visual units for various forms of car lighting plant it will be seen at once that the distribution of light is in some cases quite defective, and in most cases apparently improvable. Contrary to the usual impression, light thrown directly downward is not economically distributed, yet the usual forms of shades and reflectors seem devised to throw it as much downward as possible. A flat ring instead of the usual conical reflector should give a better distribution of the light from oil lamps, and a reflector with a decided upward flare, so as to throw off more light at an angle of 45°, should give a better distribution than the usual form of reflectors for the inverted or Pintsch type of gas burners.

We have now but two remaining articles to give before concluding our series of articles on car lighting, one of which will be on the comparative cost of lighting by the various systems, and the other on their comparative safety. On account of the space necessarily required for this week's article on car lighting and for another article of special novelty and interest giving a résumé of governmental work in aid of irrigation, we are compelled to postpone to a following issue the continuations of our articles on the Steel Skeleton Type of High Buildings and on Disputed Points in Bridge Designing.

THE New York Chamber of Commerce has followed various other bodies by heartily endorsing the Nicaragua Canal project, and has appointed a committee, including the President and Vice President, to act in the matter. The President of the Nicaragua Canal Construction Co., the Hon. WARNER MILLER, in his remarks before the Chamber, again drew attention to a fact which we fear is not as generally understood as it should be—that is, that the company under his management had never asked for government aid, and "under his management never would ask for it." This fact, in view of the declarations of the Senate Committee, as well as Mr. MILLER'S, effectively refutes the charges of "lobbying" made by some few of the papers of this country, which for the most part oppose any and all measures to aid the construction of an American ship canal across Nicaragua. We believe, with President HARRISON, that the project is one eminently adapted to direct gov-

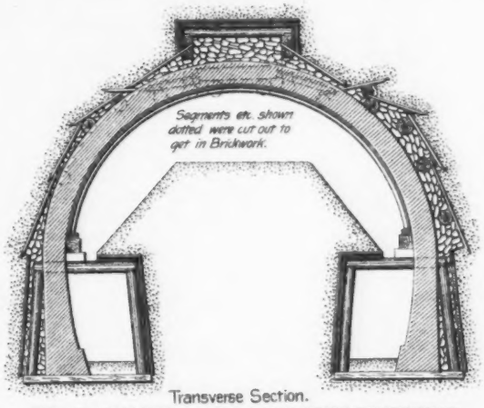


Transverse Section.



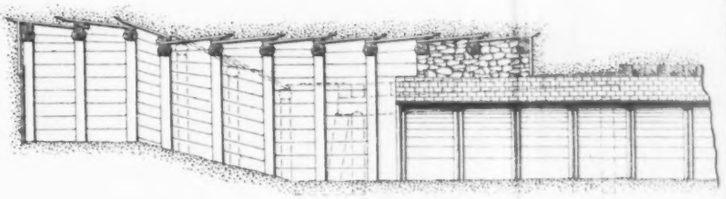
Longitudinal Section.

FIGS. 1 & 2. METHOD OF DRIVING HEADING WITH SEGMENT TIMBERING AND IRON



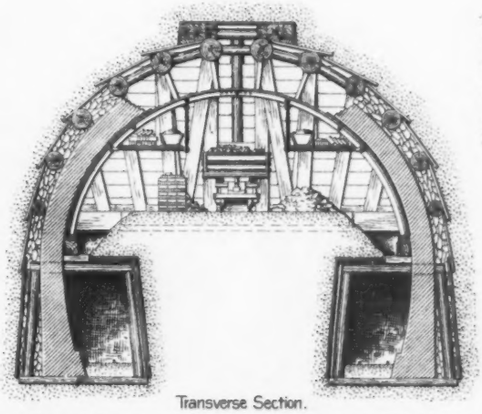
Transverse Section.

FIG. 5. CHANGING FROM SEGMENT TIMBERING TO BAR TIMBERING.

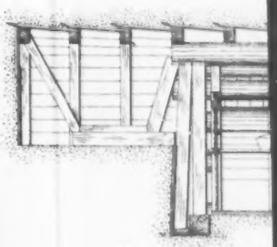


Longitudinal Section.

FIG. 4. DRIFTING BACK OVER TOP OF ARCH BUILT UNDER SEGMENT TIMBERS.



Transverse Section.



Longitu

Scales

FIGS. 10 & 11. UNFINISHED ARCH, SHOWING IRON CENTERING AND MASONS' SCAFFOLDS.

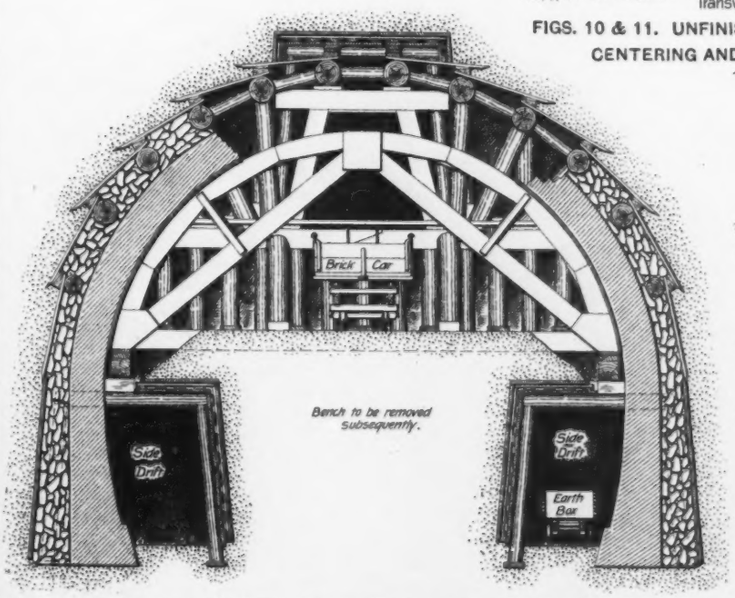


FIG. 8. UNFINISHED ARCH, SHOWING WOODEN CENTERING.

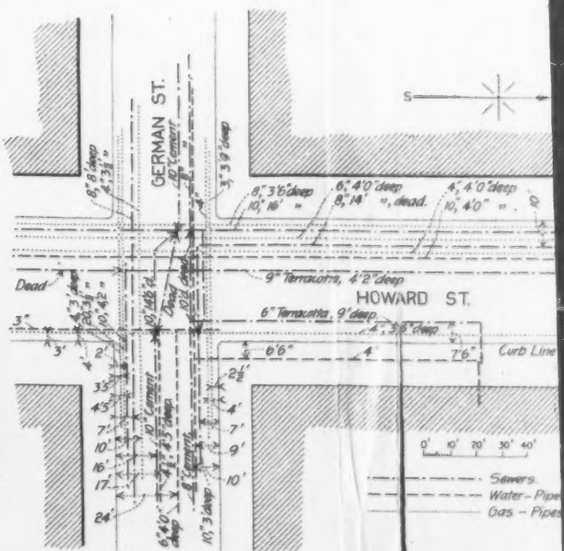
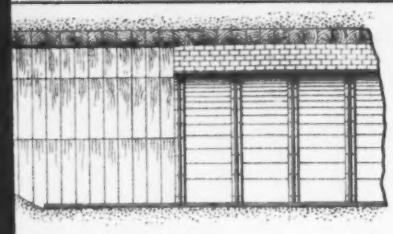


FIG. 13. MAP SHOWING PIPESOVER TUNNEL BETW

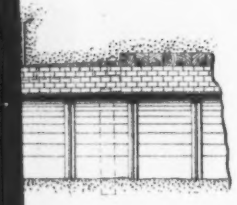
METHODS OF DRIVING AND TIMBERING

RICHARD RANDOLPH, CHIEF

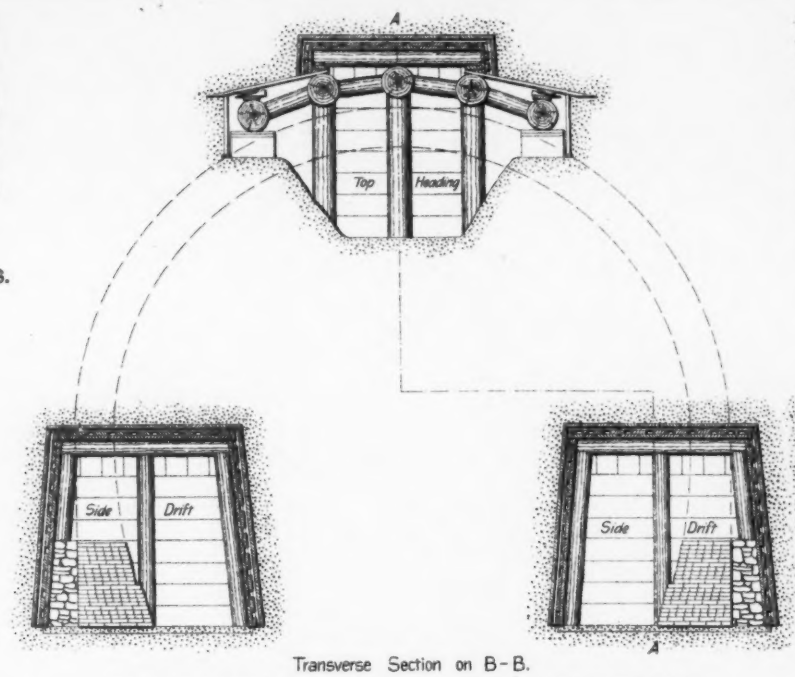


ion.

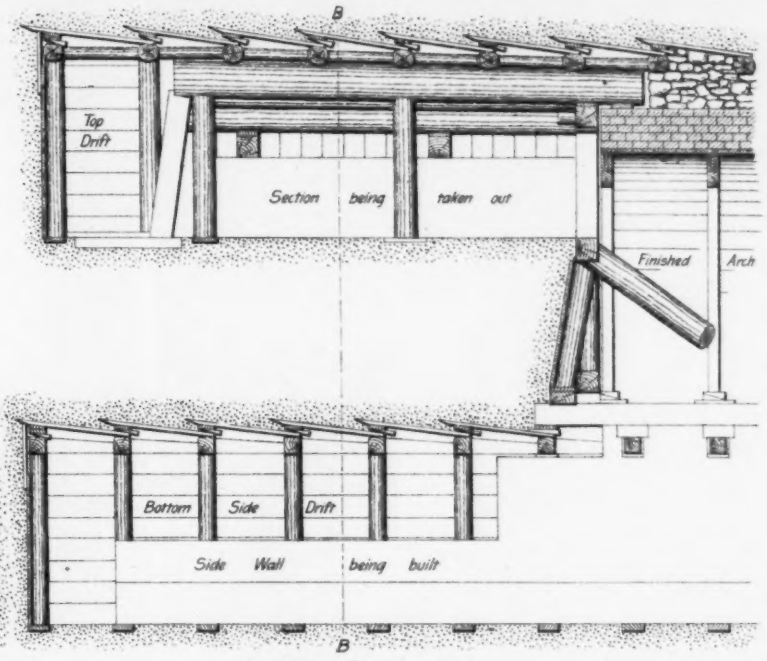
TIMBERING AND IRON POLING PLATES.



R SEGMENT TIMBERS.

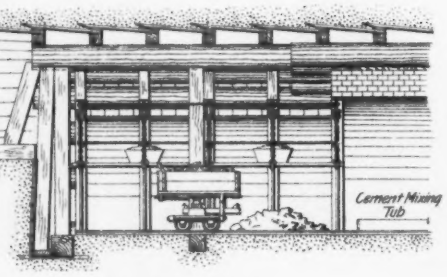


Transverse Section on B-B.

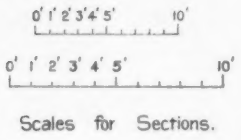


Longitudinal Section on A-A.

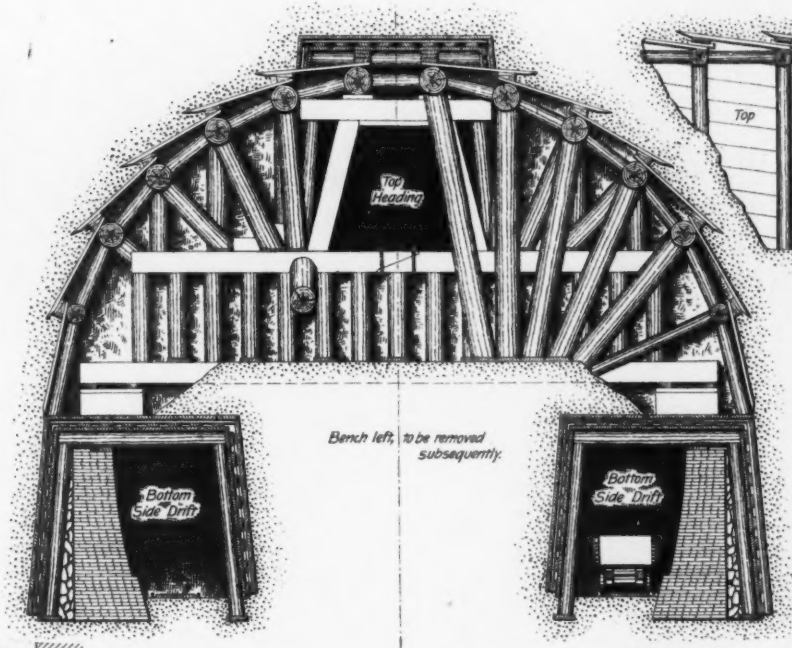
FIG. 6. WORKING FOR PROPS TO FOURTH AND FIFTH BARS.



Longitudinal Section.

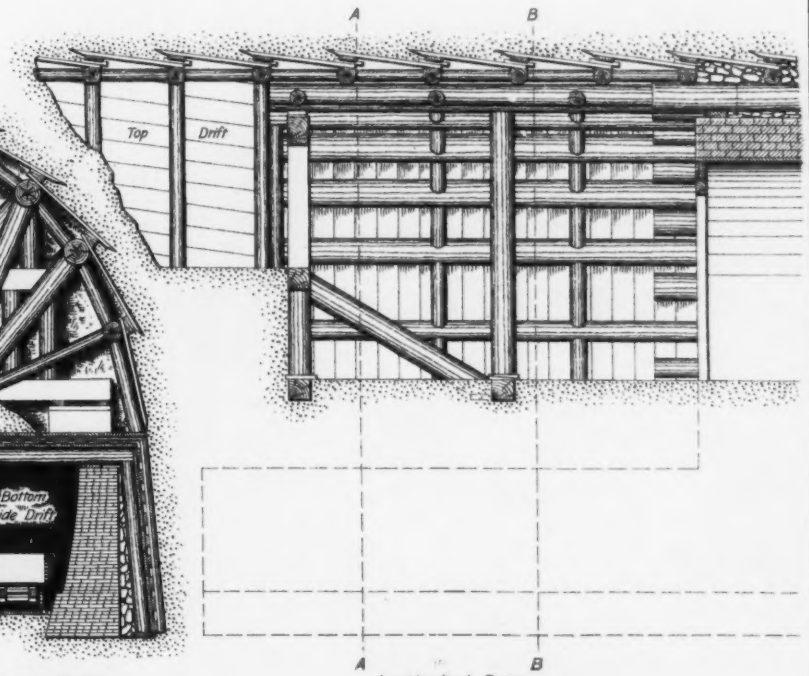


Scales for Sections.



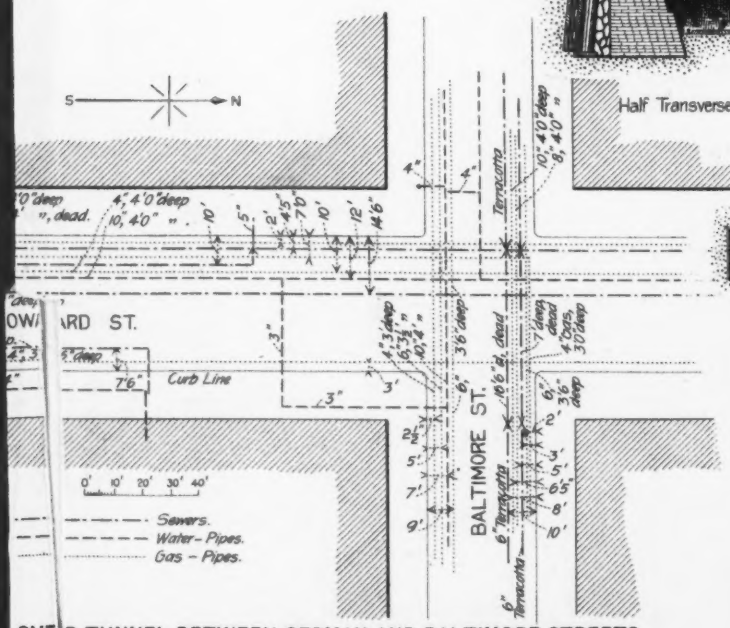
Half Transverse Section on A-A.

Half Transverse Section on B-B.



Longitudinal Section.

FIG. 7. SECTION WITH EXCAVATION COMPLETED AND TIMBERING IN PLACE.



OVER TUNNEL BETWEEN GERMAN AND BALTIMORE STREETS.

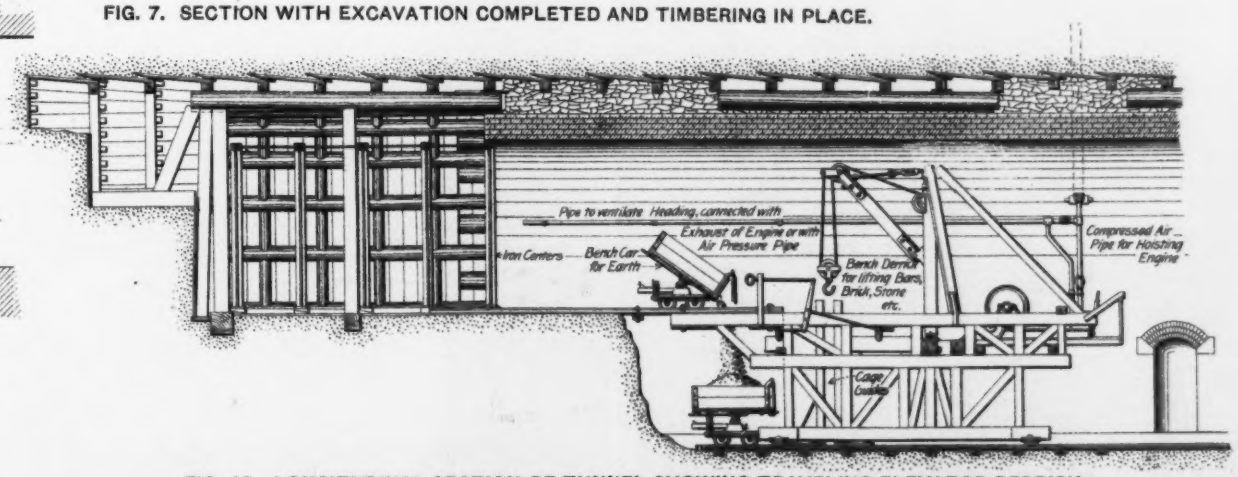

Pipe to ventilate Heading, connected with Exhaust of Engine or with Air Pressure Pipe
Bench Car for Earth
Bench Derrick for lifting Bars, Brick, Stone etc.
Compressed Air Pipe for Hoisting Engine
Cage or Cradle

FIG. 12. LONGITUDINAL SECTION OF TUNNEL SHOWING TRAVELING ELEVATOR DERRICK.

TIMBERING HOWARD STREET TUNNEL, BALTIMORE BELT RAILROAD.

RICHARD RANDOLPH, CHIEF ENGINEER. RYAN & McDONALD, CONTRACTORS.

CHAS. HART & SONS, LITH., 99 VESEY ST., N. Y.

ernment support, and that such support will mean the least interest paid during construction, more rapid and effective construction, and the opening of the canal to the world's commerce in the least time and at the lowest tolls.

The real attitude of the Construction Company to the proposed government guarantee and supervisory control, as outlined by the Senate committee, and a perfectly natural one under the circumstances, is simply this, as we understand it: The Construction Company wishes to build the canal. With a government guarantee they are sure of doing this at minimum cost and with a *small but certain* profit to themselves. Without a government guarantee the project is necessarily speculative and the capital account certainly much larger. The profits also will be speculative; possibly very large, but possibly nil. As a company the promoters of this enterprise are ready either for a hopeful speculation or a certain small return. The people who are to use the canal have but one end to secure—to keep the cost and tolls as far as possible below a speculative basis. When to this mere pecuniary difference to the people we add the large national interests involved, we are confident that the citizen or statesman who carefully looks into the question will soon be convinced that the public good demands both a national guarantee and national supervisory control.

IT has been evident for some time, as we recently noted in chronicling the last British brake returns, that in spite of the protests of nearly all the more reputable technical journals and of the invariably lower brake efficiency which the vacuum type of train brake has always shown, the temptation of greater cheapness was leading the British railways to prefer the vacuum to the Westinghouse brake. We notice lately also a subtle appeal to national prejudice in various publications by styling the Westinghouse the "American" or "transatlantic" brake in contradistinction to the vacuum, as if the latter also were not of American origin and only kept from being an active competitor in this country as in England by the fact that the Westinghouse company early absorbed the vacuum interests in this country but did not do so in England.

The English Board of Trade requires that a return shall be made to it of every instance in which a train brake fails to act properly (1) when an accident is imminent, (2) when making service stops and (3) when delay is caused to working of trains. These reports ought to be very valuable, and no doubt are so if carefully analyzed, but a very superficial examination will show that the face of the returns must be taken with a good many grains of salt. For example, the Metropolitan District Railway, which makes far more frequent stops than any other road using automatic brakes in England, reports running 794,939 miles with the Westinghouse brake, in the six months ending June 30, 1891, with "No failures and no delay calling for special remark." To be sure, all this mileage is not made with the automatic brake, the Metropolitan District being now engaged in converting its stock from the non-automatic to the automatic system. On the other hand, the Midland Railway, the very next on the list, is a vacuum road. It ran only 3,858 train miles with the Westinghouse brake, against 6,909,964 miles with the vacuum; yet it is not ashamed to report that it had six cases of Westinghouse failures in making this small mileage, or one failure for each 643 miles run, while it had only an equal number of failures with more than a ten thousand fold greater vacuum mileage, or only one failure per 1,151,161 miles!

WE have taken the trouble to compute the number of miles run per reported failure for all the roads reported. Disregarding all roads which ran less than 1,000,000 passenger train miles by either system, the record stands as follows, in order of frequency of failures:

Westinghouse roads.				Vacuum roads.			
Name of road.	Train miles, —000 omit.	No. failures.	Miles per fail., 000 omit	Name of road.	Train miles, —000 omit.	No. fail.	Miles per fail., 000 omit
L. C. & D.	1,559	50	31	Gt. No.	4,594	77	59½
No. Brit	3,337	43	77	L. & N. W.	8,688	137	63
Gt. E.	5,118	54	95	Gt. W.	8,375	63	133
No. E.	5,447	46	118	L. & S. W.	4,557	30	152
Caled.	3,345	12	277	Lanc. & Y.	4,641	25	186
L. Br. & S.C.	3,547	8	443	M. S. & L.	1,670	8	209
				Midl'd	6,907	6	1,151
Average of all roads		102		Average of all roads			113

As it is not to be supposed that any material difference exists in the quality or condition of the brake fittings furnished to the several companies, there must be an enormous difference either in the skill with which the brakes are maintained or in the care used in reporting failures, or both. By no stretch of charity can such differences as exist between the roads in either of the above tables be assumed to be warrantable. The general fact remains that the cases of real failure in service are too few to constitute a serious element with either brake, and that the real question—the question which is conveniently put and kept in the background—is, Which of the two brakes will make the quickest stop?

The Credit for New Inventions.

In the whole long list of great inventions and discoveries there is hardly one for which credit is not claimed, with more or less plausibility, for two or more men as the real, or the chief, or the first discoverer. The only exception of importance which occurs to us is perhaps the greatest of all, WATT'S invention of the low pressure steam engine. He has practically none to dispute his pre-eminence, but for the steam engine itself in its cruder forms there are such a host of possible claimants that it is quite impossible to allot any great amount of credit to any one man for a discovery of which WATT himself was only an "improver," as his epitaph states. WATT'S unique eminence springs from the fact that his "improvement" was of such importance as to first make the steam engine a working possibility, and hence he is in popular thought very justly given the credit for the entire invention.

But for the invention of the high pressure steam engine there are at least two distinct claimants who have strong claims: OLIVER EVANS, who actually built and worked one in America in 1800–1801, and then strongly urged its utility and usefulness, and TREVITHICK, who did the same thing in England in 1802. It has been claimed that TREVITHICK got his idea from EVANS and vice versa; but however this may be, TREVITHICK was so situated as to be able to do the most to bring the invention into general use, and hence he alone enjoys general credit for the invention, and not unjustly. The philosophers of the world will continue to hold the memory of each in equal honor.

But when two different inventors of this kind happen to be of diverse nationalties, other motives than abstract justice come in to lead the countrymen of each to stoutly maintain his claims, and there is apt to be enough difference in their lines of work and in their accomplished results at any given date to give the partisans of each strong enough grounds to satisfy a partisan for asserting his favorite's pre-eminence. There is an extraordinary number of great inventions whose origin is thus disputed, and with a certain justice, since there is no great invention which is not, in the form in which it is used to-day, the product of more than one mind.

The telegraph is a good example of this. In the general judgment of mankind outside of England MORSE is par excellence *the* inventor of the electric telegraph, but HENRY had made a working toy in 1832, COOKE in 1836, and WHEATSTONE, to whom the English persist in awarding the chief credit of the invention, in 1840; whereas MORSE, though conceiving the invention in 1835, and completing in 1838 (Jan. 6) the instruments which afterward sent the historic message "What hath God wrought?" from Baltimore to Washington, did not actually send that message until 1844. Moreover, as we showed at some length in our issue of April 14, 1888, the credit for the alphabet, ground circuit and other important features of the Morse system belongs not to MORSE at all but to ALBERT VAIL, a name which should ever be held in remembrance and honor, though MORSE showed throughout his life an ungenerous reluctance to concede to VAIL due credit, and his name is in fact little known.

But when it comes to the larger question of who is to have honor as *the* inventor, these minor details matter not. MORSE first made the telegraph a demonstrated commercial success, and was the original inventor *of the type which persisted and proved best suited for service*, and he will continue to be known as the father of the electric telegraph, though many other names will be held in honor.

In like manner the credit of inventing the telephone will go to BELL, though GRAY was a simultaneous if not earlier inventor, and PHILIP REIS (1861) anticipated them both in "conceiving the idea" of the device, and even coined its present name. WHEATSTONE himself made some successful experiments in electrical transmission of sound waves in 1831, and with almost as much reason may be claimed to be the first inventor of the telephone as of the telegraph.

In like manner the world, outside of England, agrees to regard FULTON as the inventor of the steamboat, though half a dozen men in three or four different countries had made boats which moved by the power of steam in 1760, 1783, 1786 (on Potomac River), 1802 (SYMINGTON'S "first practical steamboat," the *Charlotte Dundas*, which made one trip and dropped out of sight), and other dates prior to 1803 (when FULTON made his first tests on the Seine), and 1807, when the *Clermont* made the immortal trip which first made steam navigation a success. In like manner the invention of the screw propeller is by the general judgment of mankind credited to ERICSSON, though FITCH, as far back as 1796,* propelled a little steamboat with a screw on the pond where the Tombs now stands in New York, while STEVENS used the screw (and also the twin screw) with boat engines which still exist, as far back as 1804 and 1805. Both FITCH and STEVENS achieved such success that, had it not been for FULTON'S monopoly of navigation rights, the screw would probably have supplanted the paddle in the early dawn of steam navigation. WATT himself proposed the screw for propulsion in 1784, EVANS in 1801–2, and TREVITHICK in 1804. Their connection with the invention is very justly forgotten by all but antiquarians.

In like manner the locomotive is justly credited to STEPHENSON though CUGNOT built one that would run in 1769, and numerous others (including STEPHENSON himself) made more or less successful machines prior to the construction of the Rocket, which is yet justly regarded as the first really successful locomotive.

In like manner the prototypes of Col. COLT'S revolver may be found in half the museums of Europe, antedating him by centuries. MCCORMICK'S reaper had been in a certain sense anticipated. HOWE'S sewing machine had been so generally anticipated that all he could really hold of it was his claim on the eye near the point of the needle, and from this essential feature he derived both his millions of royalty and his just fame as *the* inventor of the sewing machine.

So we might go on for pages with instances of men who anticipated by suggestions or partial successes almost every known great invention.

* FITCH had been building steamboats since 1785, and several of them had been quite successful prior to 1796. In one of these he had placed what was probably the first water tube boiler.

BRUSH probably deserves more credit than any other one man for the introduction of electric lighting, but he has several contestants for the honor. TREVITHICK suggested the possibility and some essential features of the modern rock drill in 1803. Others followed who contributed vastly more toward working out the idea than he; hence they now enjoy all the credit. It is just that they should. Often the order of time is reversed. Thus, the Bessemer process was nothing without speigeleisen, and MUSHET, not BESSEMER, suggested and demonstrated its usefulness, while HOLLEY did no little to make the process a commercial possibility on the modern scale. But BESSEMER did so much more than either, or than all others together, to create the Bessemer process, in addition to enjoying an undisputed priority, that the process will justly and for all time be known by his name.

Through all these instances runs the same general principle, a principle founded upon the plainest equity, and easily lived up to by disinterested observers, but yet one which it is easy to forget and find excuses for forgetting, when influenced by personal or national prejudices. He alone is entitled to claim credit as the inventor or discoverer of any valuable process who (1) actually reduces the process or device to such complete form as to hold out the "promise and potency" of usefulness without further essential modifications, or (in the event that several fulfill this condition), who (2) devises the particular form of the device which subsequently proves to be fittest for survival. Mere suggesters, or unsuccessful or unpersistent experimenters, are entitled to *no* credit as inventors, either in law or equity, however much credit they may deserve and receive as men of science or of fertile imagination. It is natural and inevitable that almost every device should be "in the air," so to speak, before it becomes an accomplished fact; that the minds of thousands should be pondering over every great possibility before it is attained. It is even more natural that two or three out of these thousands should have skirted the edge of complete success without actually reaching it. When two or more men are almost simultaneous discoverers, as in the case of the telephone, an equitable choice is often very hard to make, but priority by even a few hours must decide. When there is a longer interval of time between contestants, the choice is less difficult. When the interval is very long, there is no difficulty at all. He who has merely suggested some possibility, or even partially proved it, and then dropped it without necessity for one, two, three or more decades, doing nothing whatever meantime to convert his thought into a fact, thereby forfeits *all* his equity in either the honor or the profit which may be derived later from his inchoate invention. He can claim honor as a suggester only, not as an inventor.

Especially and pre-eminently is this true when an original suggester enjoys exceptional advantages for bringing forward his suggestions to fruition, if he really believes in them, and is really competent to work them out; and this was pre-eminently the case in regard to the process for rolling of sheet metal from liquid steel, which Mr. (now Sir HENRY) BESSEMER suggested and took out a patent for in 1857, but thereafter did nothing with until the process was recalled to his memory by a successor who actually accomplished what he had only suggested. The circumstances under which this occurred were recounted in part in a late issue, in Mr. R. W. HUNT'S presidential address before the American Society of Mechanical Engineers, but seem to us so notable that we shall next week give them in full in Sir HENRY BESSEMER'S own words. Whether or not the process will ever amount to much practically is still far from clear, but for that very reason the facts seem worthy of record.

CORRESPONDENCE.

Vicksburg Still a River Town.

ST. LOUIS, Dec. 15, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR:—In your issue of Dec. 12 you say, "Vicksburg, once a flourishing river town, is now about seven miles distant from the Mississippi, that river having cut its way across the base of the peninsula that formerly fronted the city, nearly on the line of Gen. Grant's famous canal."

This statement is erroneous in several particulars. In the first place the elevator at Vicksburg where steamers formerly landed is only about 6,090 ft. from the river proper and at high stages of river is still readily reached. At low stages a cut is made by dredging to admit boats.

Grant's Canal had no influence whatever in the formation of the cut-off as is commonly supposed. The cut-off was made in 1876 at a point more than two miles below said canal.

The feasibility of diverting the Yazoo River has been discussed for many years, and careful surveys were made by Mr. T. G. Dabney in 1877-8. A board of U. S. Engineer officers, appointed at the request of the citizens of Vicksburg to investigate the matter, reported in 1878 "That the discharge of the Yazoo at low water is too small to remove the immense accumulation of mud already in place but it might obviate the necessity of annual dredging if the works were once "completed." Many engineers believe that this is the true solution of the problem.

In the meantime Vicksburg still is, and will doubtless continue to be a "flourishing river town."

J. A. OCKERSON.

[As our correspondent is in a position to know of what he speaks, we accept his correction of a note taken in substance from a Southern Exchange.—ED. ENG. NEWS.]

Mr. Dredge and the Chicago Exposition.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The inclosed appears in *The American Machinist* of to-day and is certainly startling. That there has been an attempt to ignore Mr. DREDGE'S services in the case appears evident, and in confirmation I inclose the extract from the *Marine Record*. Their original statement was, that Mr. DREDGE "who accompanied Sir HENRY WOOD, the British commissioner," &c. Anything belittling Mr. DREDGE'S efforts is an insult to the whole engineering profession. There is no man who has done more than he to elevate engineers and to bring about a cordial state of feeling between American and English engineers. To ignore him in the slightest is not only to deprive the fair of a valuable assistant but it is the height of ingratitude.

The trouble in Mr. DREDGE'S case is his modesty. He sat by during the visit of the American engineers to England and heard praises bestowed on other men for his work without a murmur, or even an explanation. He started and carried forward the English exhibit at Paris, even guaranteeing a large amount from his private purse in case the exhibit failed. It was through his efforts that Mr. HENRY WOOD was made Secretary of the British Commission in Paris, and it was for this service Mr. WOOD was knighted. Mr. DREDGE spent a large amount of money in the service of the commission in Paris, and gave months of his valuable time to developing its work, and when Mr. WOOD was honored he never complained, but wished him success.

It was Mr. DREDGE who started the commission for our fair. He did as before, came over to attend the work of organization, and, as before, put aside his business and bore all his own expenses. He never complained when Sir HENRY WOOD, who was again made secretary of the commission, received attention as the chief commissioner, and was placed at the principal seat in the various banquets. If there is anything which ought to make a man noble, whether titled or not, it is to see his best acts credited to another and not to protest for fear of disturbing the existing harmony necessary to success.

So far as Sir HENRY WOOD is concerned, the writer knows he had no part in these arrangements, nor is he a man whom any Chicago committee can manipulate. That he ought to have at once put matters in their proper shape while here there is no doubt, and that he failed to do so is not to his credit. But the effusive hospitality and the almost subservient deference paid him at Chicago seem to have either blinded him to the end in view, or he may have argued this was Mr. DREDGE'S affair and not his.

ALPHA.

[We reprint the extracts referred to as follows:

The London correspondent of the New York *Times* calls attention to the fact that the Chicago papers of the 24th ult. printed the report of the two delegates deputed to visit Chicago on matters connected with the World's Fair as though it were made by Sir HENRY WOOD alone, whereas, as a matter of fact, JAMES DREDGE, the editor of *Engineering*, was the principal person responsible for it and wrote most of it, WOOD being merely a paid secretary. It is said that they even went so far as to change the reading all through by substituting "I" for "we." It is charged that this was done for the purpose of offering an affront to DREDGE, to induce him to resign, as he is a man who cannot be "used" or handled by those in authority at Chicago. We do not, of course, know just how much there may be of truth in all this, but we are very confident that the interests of the show will be very badly injured by allowing anything which has the appearance of being inspired by any such motives. Possibly this matter has been explained to the satisfaction of Mr. DREDGE, but we have seen no explanation of it, and it would seem that an explanation would be in order.—*American Machinist*.

We desire to correct a statement regarding the British Commission who visited Chicago. In speaking of them we included Sir HENRY WOOD as a member. We have learned since that this was an error. Mr. DREDGE was the only commissioner and Sir HENRY WOOD, although employed as secretary to the commission as he is to the Society of Arts, is not a member of either body. It may be further stated that Mr. DREDGE paid all the expenses of his recent trip and that the Royal Commissioners receive no salary or allowances, while their secretary receives both.—*Marine Record*.

These journals, like ourselves, were originally misled by the erroneous statements in the daily press. We most heartily join with our correspondent in his correction of these press reports, and as heartily in his praise of the unselfish work of Mr. DREDGE in promoting engineering effort and fellowship here and abroad. We knew personally of the invaluable services performed by this gentleman in connection with the memorable visit of the American engineers to England, and his services in connection with the Paris Exposition of 1889 are fully recognized by the engineering world generally, even if the English Government did give to another the reward justly his.—ED. ENG. NEWS.]

Separate Water Supply for Extinguishing Fires.

PHILADELPHIA, Dec. 14, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: When in Cleveland, O., the other day, the writer chanced to learn that the Water Department of that city had recently made a successful test of a new, heavy 6-in. main, laid from the river some one thousand feet or more up into the business portion of the city. By bringing the city's fire boat to a connection with this main, it was found possible to supply a full head of water at the upper end of the main, at a pressure of about 300 lbs., which, as you will readily appreciate, would give one or more powerful fire streams; the test at Cleveland through a short length of fire hose, attached to the upper end of the main, resulting in a stream of much greater power than it was possible to obtain from their fire engines, using ordinary city supply, under similar conditions.

The results, I am told, were so satisfactory that it is proposed to put in a number of these mains of greater or less lengths, along various streets leading from the river back into the business centers. All of these mains will have dead ends and be entirely independent of the ordinary city water supply; when not in service remaining empty, being so laid as to readily drain.

It would seem that the use of such mains in connection with your fire boats in New York might very materially increase the efficiency of the Fire Department in dealing with large fires, especially if supplemented by suitable signaling devices.

Yours very truly,

L. R. LEMOINE.

[A similar system has been suggested for New York, and several years ago a company was organized to put a scheme into practice, which included a powerful pumping station on the river and a stand-pipe for keeping the mains always full and under pressure. Empty mains, as spoken of for Cleveland, would mean a serious loss of time in a distribution system large enough for the needs of down-town New York. Nothing has yet been done, however, in carrying this scheme into effect; owing probably to the great cost of the separate pipe system and necessary plant, and to the further fact that under normal conditions there is water enough in the present system of mains for a fire supply. The idea is an excellent one, however, and could doubtless be profitably applied in some of the smaller cities located on rivers or lakes. The fire boats are now used in New York, for extinguishing fires at some distance from the river, by connecting long lengths of hose.—ED. ENG. NEWS].

Notes and Queries.

P. A. R. asks which is the most rational method of setting grade stakes on curves: To set them at the level of the outside rail or of the inside rail. There is not sufficient choice to make the point worth much discussion. General practice favors the inside rather than the outside rail, for the reason that the inside rail is usually carried around on grade and the outer one elevated; but either may be used. Some engineers set both inside and outside stakes at a fixed distance from the center line, setting neither of them at the elevation of the rails, but at such height that a straight edge laid on them will define the proper height for both rails.

What the Government Is Doing to Advance Irrigation Interests.

BY HERBERT M. WILSON, M. AM. SOC. C. E., ENGINEER U. S. GEOLOGICAL SURVEY.

The second part of the eleventh annual report of the Director of the U.S. Geological Survey has just been presented to Congress, and is devoted to an account of the work of the irrigation survey during the fiscal year. The report contains valuable information relative to the researches of the government into the hydrography and topography of the arid west, besides showing that much excellent engineering work has been done, and many reservoirs selected and withdrawn from entry.

HYDROGRAPHY.

The operations of the parties of the irrigation survey engaged in the investigation of hydrographic phenomena have been pushed with vigor. The field work of these parties has extended over a wide range of territory, including a majority o the main drainage basins in the arid region. This work has been under the immediate supervision of Mr. F. H. NEWELL, Chief Hydrographer, ably aided by a large corps of assistants distributed over the field of operations. The results of their work after tabulation in the office furnish a vast amount of information relative to the discharge of the more important streams, besides showing the proportion of run off per square mile of catchment basin. The percentage of total rainfall on the basins examined furnishes the means whereby an approximate estimation of the discharge of streams which have been gaged can be obtained. In the regions studied some experiments were made to ascertain the amount of evaporation, and on the Rio Grande an attempt was made to determine the percentage of sediment carried in suspension.

The object of the hydrographic survey was the the solution of practical problems bearing on the preliminary study of the various irrigation projects examined. One of the first points to be settled in the consideration of any irrigation problem is the source of water supply. It is necessary to know not only the average flow of the stream from which this supply is to be derived but also its minimum discharge and its highest maximum flood discharge. The determination of these quantities affects materially the dimensions given to a canal or storage reservoir and the character of the diversion weir or impounding dam.

Before a canal or storage work is built the average amount of evaporation, and if possible the amount of loss by seepage or percolation through the soil, should be known. These quantities affect the carrying capacity and consequently the dimensions of the canal, and in designing the latter its cross section is diminished by the engineer in proportion as water is used or lost either for beneficial purposes or by absorption. Likewise the capacity of the reservoir is affected by the loss by absorption from its surface, or by percolation, and the estimates made of the quantity of water stored must take into account the diminished volume of this as a result of the losses produced by absorption. The question of the amount of sediment carried in suspension by streams is one the solution of which is within the province of the hydrographer. The amount of this sediment seriously affects the character of the diversion works at the head of the canal, and also the grade and consequent velocity given the water in the canal, in order that the sediment may not be deposited in the canal but shall be held in suspension until the irrigable lands are reached. The amount of sediment carried by a stream the waters of which are to be stored in a reservoir may be so great as to prevent its construction, since with some streams this sediment may be sufficient in quantity to completely fill the reservoir in a comparatively short period of years.

In this country there have been two general classes of investigation of water supply: Those made by army engineers for the purpose of improving navigation and those made by civil engineers for municipal supply and water power. The volumes measured and discussed by the former are generally great, and deal with the discharges usually of navigable rivers. Those of the latter are relatively small and deal with minor streams derived from relatively high secluded catchment basins. The investigations made by the hydrographers of this survey have dealt with quantities intermediate between these two; the largest of the streams examined, as the Rio Grande in New Mexico, or the Upper Missouri in Montana, being relatively small compared to the Potomac, Hudson or Mississippi rivers, yet great as compared to the Croton watershed or that of the Cochituate Basin near Boston.

Of the four general methods for measuring the discharge of a stream the one used almost exclusively by the Geological Survey is that which employs current meters. Floats have been used to a limited extent to obtain the approximate discharge of a stream under peculiar circumstances, and weir measurements have been made in a few cases to obtain the discharge in ditches. Discharge results obtained by calculations based upon the slope, area or cross section and depth of the stream have not met with favor or confidence. After the measurements have been made with accuracy, the result is seriously affected by an assumed factor of roughness of the bed. For the diversified needs of the survey it has been found most convenient to have two types of current meters: The direct recording meter, in which the number of revolutions is indicated directly through a series of geared wheels driven directly by the vane wheel of the meter on dials exposed to view, and the electric meter, in which the counting is done by means of a simple make and break circuit, the register being made at any desired distance from the meter. For shallow quiet streams, where the gager can work comfortably from a bridge or boat, the direct recording meter is preferred. In deep and tortuous rivers, however, the current is usually too strong for a man to hold the meter or lower it to the bottom. However, in floods it is often impossible to go out upon the stream, and in these cases electric meters suspended from overhead cables become a necessity.

The direct recording meters used by a survey are modifications of the Colorado meter recommended by Mr. E. S. NETTLETON, ex-State Engineer of Colorado, from the results of his experience. The wheel revolves in a horizontal plane and consists of five cups similar in principle to the cup anemometer. The electric meters used by the survey are nearly all modifications of the Haskell direction current meter, the velocity wheel and tail being screwed into a convenient swivel or rod support. The wheel is of the propeller type, conical in longitudinal projection, thus cleaning itself of leaves and grass. The flukes are given a strong pitch, and are so proportioned as to cause the wheel to revolve at ordinary velocities once at about a foot for linear movement of the current.

Each meter before the results can be obtained is rated; that is the relation which exists between the speed of the wheel and the velocity of the water must be ascertained. The survey has through the kindness of the officials in charge of the Denver reservoir, been able to construct there a rating station to which all meters are sent to test their accuracy. A course of 100 ft. is laid off with sufficient length at either end to start the car at the speed to be kept up over the course. As the meter passes into the measured distance, the measure and stop watch are automatically started and continue until the meter leaves the 100th ft., when both are stopped. From observations thus made the rating is determined either by analytic or graphic solution.

There are several ways in which the meter can be used in determining the total flow of the stream, depending upon the fact that the velocity of the water varies in different parts of the stream, being swiftest, as a general rule, in the center, near the surface. In wide, deep rivers meter measurements are made at a number of places evenly distributed across the stream, and at each of these places observations are made of the velocity near the surface, bottom, and at various intermediate points. The average velocity of all is taken to be the average velocity of the whole river, the discharge being obtained by multiplying the total area of cross section at this point by the average velocity. In shallow streams, however, such as are most of the rivers of the arid region, the work is shortened by what is called integration. Instead of using the meter at various given points in a vertical plane, it is moved at a very slow uniform speed up and down from top to bottom to obtain an average of the velocities at all points in the vertical plane.

The rivers gaged up to the present time have seldom exceeded 500 ft. width and have generally been much narrower, and thus it has been possible in all cases to stretch one or more cables over the stream at the cross section. The equipment of the station varies with the method of gaging. In general the following applies to most of the stations operated by the survey: First, a tagged wire is fastened securely over the section for gaging at a height out of reach of the highest flood; this carries a number of tags 5, 10 or 20 ft. apart according to the width of the stream. At a short distance upstream from this wire, 20 to 50 ft. or more, a ⅛ to ¾-in. wire cable is stretched across the river and on this a pulley or other trolley runs to which a boat is fastened, the whole being in short a small rope ferry. In high floods, however, a boat cannot be held in this position on account of the velocity of the water and the danger from driftwood. To overcome this difficulty two methods have been tried, that of gaging from a car suspended above the water, and the cable and traveler method, by which gagings can be conducted from the shore by means of an electric meter.

After the station is occupied, and daily gage readings counted, the rating of the station is undertaken. This is the main and most expensive operation of the hydrographic work, as it is necessary to measure the discharge at various heights of water. To get a complete series of measurements is usually a matter of several months, as the height of the river cannot be predicted except in the most general way. The results of these measurements are plotted, and the points thus obtained generally lie in such a position as to suggest the path of a simple curve, which is usually sketched by eye. When the curved line has finally been adjusted a rating table is constructed, which gives the discharge in cubic feet per second for each foot of height on a gage rod at the station.

At the beginning of operations of the hydrographic survey the necessity of sufficient rainfall measurements was appreciated. As the Signal Office was not then in a condition to give some points at which measurements were most needed for the hydrographic survey an attempt was made to supply this deficiency by establishing a system of volunteer observers. In the Rio Grande basin alone 40 rain gages were thus located at accessible points, nearly the same number in the Gila basin, Arizona, and a few in the basin of the Arkansas in Colorado and of the Truckee River in Nevada. The results obtained by the measurements of precipitation carried on by the survey were transmitted from time to time to to the signal officer, and by him published in the Monthly Weather Review. The relation between rain or snow fall and the amount of this which runs off into the streams is a problem of scientific interest and value, and one which has a practical importance for engineers. This relation it has been the endeavor of the survey to establish as far as practicable for the various hydrographic basins gaged and on which the precipitation was measured. This relation, known as the "run off" of the basin, is usually expressed as so many inches in depth over the area, or such a percentage of the depth of rainfall, or as so many second-feet per square mile of catchment area.

The evaporation measurements mentioned in the first annual report of the irrigation survey have been continued at places where there was especial need of data for engineering estimates. Evaporation observations were made during the year at the following places: Fort Bliss, near El Paso, Tex.; Embudo, N. Mex.; Tempe, Ariz.; Florence, Ariz. Yuma, Ariz.; near Denver, Colo.; Cañon City, Col., and at Fort Douglas, near Salt Lake, and at several other localities in Utah and Montana at which the records from various causes are fragmentary.

Gagings were made on the Yellowstone River in Montana at several places, the object being to ascertain the amount of water available at the lake outlet for storage purposes in the Yellowstone Lake and also the perennial discharge at possible points of diversion for canals. The discharge from the lake according to various observations made in 1873, in 1886 and 1889 indicate that its average minimum discharge ranges from 586 to 1,525 second-feet, its minimum flood discharge being much higher than its average. Near the town of Horr on the southern border of the National Park measurements were begun in August

in 1889, and continued during the remainder of the year. In the following March the station was moved about a quarter of a mile lower down the river, and the work continued. These measurements showed a minimum discharge of the Yellowstone at Horr of 510 second-feet in March, 1890, and a maximum 11,915 second-feet during May and June, 1890. The mean discharge during the irrigating season varied between 4,375 and 10,086 second-feet.

The main eastern branch of the Missouri River above Three Forks is known as the Gallatin River, and on this a gaging station was located at the mouth of the cañon about 20 miles above the city of Bozeman, Mont. The results of the measurements show that the least discharge during the fiscal year occurred in April, 1890, and amounted to 280 second-feet. The maximum discharge was 3,800 second-feet in June, 1890, while the mean discharge during the irrigating season varied between 760 and 2,000 second-feet.

The Madison River, the central branch of the three tributaries of the Missouri, was gaged at a point below the mouth of Hot Spring Creek, 4 miles from from Red Bluff. The results of these gagings showed that its minimum discharge, which occurred in April, 1890, amounted to 1,370 second-feet; the the maximum discharge during the irrigating period ranged between 1,500 and 5,000 second-feet.

The Jefferson River, the western tributary of the Missouri, was not gaged on its lower course. One of its upper tributaries, however, Red Rock Creek, was gaged at the town of Red Rock, Mont. The minimum discharge of this stream during the year was about 40 second-feet, the maximum 675 second-feet and the mean, during the irrigating season, varied between 50 and 577 second-feet.

The Missouri River, formed by the union of the three streams above mentioned, was gaged at Toston, Mont., where it had an average discharge ranging between 3,700 second-feet in July and 14,440 second-feet in May, 1890. At Cañon Ferry, 18 miles from Helena, the Missouri was gaged during the three fall months of 1889, at which time its mean discharge ranged between 1,873 and 2,502 second-feet. Not far from Great Falls, lower down on the Missouri, this river was also gaged in the spring of 1890, when its minimum discharge amounted in August to 1,000 second-feet and its maximum discharge to 12,500 second-feet.

The Sun River in northern Montana was gaged at a point about 18 miles above the town of Augusta, and 75 miles above the town of Great Falls, at the junction of this stream with the Missouri. Its minimum discharge amounted to 160 second-feet in April, 1890, and its maximum to 4,085 second-feet in May, 1890. The mean during the irrigating season ranging between 370 and 2,804 second-feet.

In Colorado the gaging of a few of the streams has been conducted during a period of years by the State Engineer of Colorado. The Cache La Poudre Creek has been constantly gaged since 1884. The station is situated about 12 miles above Fort Collins. The results obtained from these gagings are of more than local interest, as they may be taken in a certain degree as representative of the condition of other streams over a large portion of the arid region. During the irrigating season, from April to September, the lowest recorded discharge of this stream occurred in 1889, and was 67 second-feet. In April of the same year the discharge was as low as 113 second-feet. The highest recorded discharge during this period occurred in June, 1884, and amounted to 4,812 second-feet.

The Arkansas River is in many respects a typical river of the arid region, both in its topography and régime. It rises in the snow-mantled mountain slopes of central Colorado, where its catchment basin varies from 5,000 to 14,000 ft. above sea-level. On the headwaters of this river were established 8 gaging stations, the first and highest of which is on the east fork of the river, about 3 miles from Leadville, at the outlet of the proposed reservoir site. There are others on the Tennessee fork, 5 miles from Leadville, one on Lake Fork, 6 miles from Leadville, and 10 miles below the union of the forks is still another. Gaging stations were also established at the site of the Twin Lakes reservoir on Clear Creek and on Cottonwood Creek. None of these streams have large discharges. They vary between a minimum of 10 second-feet on the South fork of the Cottonwood to a maximum of about 550 second-feet on Twin Lake Creek. The principal station on the Arkansas River, however, is near Cañon City. This was located in 1888 by the state engineer of Colorado and has been continued without intermission ever since. The mean discharges during the past 3 years and for the irrigating season show a minimum discharge of 220 second-feet in September, 1889, and a maximum discharge of 2,000 second-feet occurred in 1888 and 1890. The maximum recorded discharge for the same period amounting to 3,270 second-feet. This stream was also gaged at Rock Cañon, Pueblo and La Junta, Colo.

Careful and continuous gagings were conducted on the Rio Grande at Embudo, N. Mex., at which point was established early in 1889 the headquarters of the hydrographic division of this survey, where experiments were made and methods of operation perfected. These gagings are continuous since January, 1889, and show a minimum discharge of the river during the irrigating season of 181 second-feet in August, 1889, and a maximum discharge for the same period of 6,071 ft. in May, 1890. Gaging stations were also established on the Rio Grande at Del Norte, Col., and at El Paso, Tex. At the former place the mean discharge during the irrigating period ranged between 612 and 4,531 second-feet, while at El Paso for the same period it varied between 424 and 5,771 second-feet.

A few gagings were conducted over a short period of time on the San Pedro Creek, in Arizona, and the Verde River near Fort McDowell, in Arizona. The principal gaging stations, however, in this territory were on the Gila and Salt rivers; in the former case above Florence and in the latter about 20 miles above Phœnix, in Arizona. The mean minimum discharge during the irrigating season on the Gila River was 28 second-feet in June, 1890, while the maximum during the same period amounted to 3,137 second-feet in August of the same year. On the Salt River the mean minimum discharge during the irrigating period was 470 second-feet in June, 1890, and the maximum 3,975 second-feet in April of the same year. This river is subject to great floods of unusual magnitude, the greatest of which occurred in February, 1890, and amounted to 143,288 second-feet.

On the western slope of the Sierra Nevada, in California and Nevada, stream gagings were conducted during the past year on Prosser Creek, near Boca, Cal., on the Little and on the Big Truckee Rivers near the same place. On the Truckee River near Essex, Lawtons and Vista, Nev., gaging stations were established early in 1890, and continued up to the end of the fiscal year. Gaging stations were likewise maintained during 1890 on the East Carson near Rodenbaugh, Nev.; on the West Carson at Woodford, and on the main Carson River near Empire, Nev.

In Idaho the Bear River was gaged during 1889 and 1890 at Battle Creek, also near Colliston in Utah. The gaging station at this place was maintained near the head of Bear River Canal, and shows a mean minimum discharge of the river during the irrigating period of 362 second-feet in July, 1889, and a mean maximum discharge during the same period of 7,924 second-feet in May, 1890. The Ogden River, the waters of which are now being utilized for irrigation, was gaged at Powder Mills, Utah, and showed a mean minimum discharge during the irrigating period of 312 second-feet in August, 1890, and a mean maximum discharge of 1,818 second-feet in May of the same year. In Utah gagings were also conducted in 1889 and 1890 on the Webber River at Devil Gate; on the American Fork; on the Provo River near Provo; on the Spanish Fork near Spanish Fork, and on the Sevier River near Leamington.

In Idaho the North fork of the Snake River was gaged during 1890 when its mean minimum discharge amounted to 1,450 second-feet in August, and its mean maximum discharge to 4,580 second-feet in May. The Fall River, a tributary of the Snake, was gaged in the cañon, and the Teton River at Chase Ranch. The main Snake River below the forks was gaged at Eagle Rock during 1889 and 1890, when its mean minimum discharge during the irrigating season amounted to 2,596 second-feet in August, 1889, and its mean maximum discharge to 35,606 second-feet in May, 1890. In addition to these gagings others were conducted in Idaho on the Wood River, at Hailey; on the Owyhee River, at Riggsby, Ore.; on the Malheur, at Valley, Ore., and on the Weiser River at Cañon, Idaho.

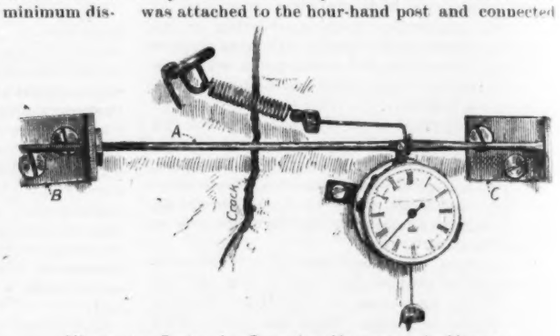
In addition to these permanent stations, temporary gagings were made at numerous points throughout the arid region wherever the hydrographers had opportunity to spend a few moments and establish a station and make gagings. A great many of these were made on the various forks of the Yellowstone and Missouri Rivers, in Montana; of the Gila River in Arizona; on the Rio Grande in New Mexico and Colorado, and upon the various streams in the Truckee, Carson, Salt Lake and Snake River basins.

(To be continued.)

An Indicator for Detecting Movements in Masonry.

We are indebted to Mr. E. P. ABBOTT, Chief Engineer of the Minneapolis & St. Louis R. R., for a photograph of an ingenious device recently used by him to detect movements in a bridge abutment. After building the south abutment for the Second St. bridge in Minneapolis, a crack appeared in the masonry which threatened to be serious. The abutment was very heavy, being 83 ft. long and 10 ft. thick at the base. In order to determine whether the crack was gradually widening or was remaining stationary, the device illustrated in the accompanying sketch was placed on the abutment. It is described by Mr. ABBOTT as follows:

On one side of the crack the works of a Waterbury watch were firmly secured and a short lever was attached to the hour-hand post and connected



Micrometer Device for Detecting Movements in Masonry.

to the rod *A*. As will readily be seen, the least widening of the crack would be multiplied through the train and indicated on the dial ($\frac{1}{16}$-in. opening would cause over a revolution of the pointer). The spiral spring took up all the slack in the joint between the lever and the long rod; and the weight *W*, attached to a piece of silk running around the pointer spindle, took up all the slack in the train.

By means of the nut on the inside of the stop *B*, the end of the rod was brought just to contact with the stop *C*, and an ordinary battery was connected to form an electrical circuit through this contact. It is therefore evident that if there was any movement it would be detected by the battery as well as by the indicator, thus securing a double test.

The entire cost of the whole outfit was about $6, and it well accomplished its purpose, demonstrating absolutely that the masonry remained stationary for three weeks after the device was put on.

How to Prevent Leaky Flues.*

Generally speaking, it costs more to maintain the flues and keep them in repair than any other part of the boiler. Among the causes for this are the following:

(1) Inferior material; (2) poor workmanship; (3) bad water; (4) ill treatment of the boiler.

As to material, the best is the cheapest in the end. Steel and iron are the materials almost universally used for boiler tubes at the present time, which may be due to the fact that they are cheaper and have greater strength

* Condensed from a paper read by Mr. F. A. Stinard at the November meeting of the New York Railroad Club.

than copper or brass. Either metal should be homogeneous, devoid of phosphorous or any other substance that would tend to make it brittle. It should be just ductile enough to permit it to be extended without fracture, as in this respect, I believe you can go too far, and make it so soft that the remedy is, so to speak, worse than the disease.

The writer has found the following method of preparing the flues for setting to give the best results: The ends are first annealed, then put into a die and reduced in diameter just enough to get them into the thimble after it has expanded in the flue sheet. If the end of the flue is hardened by contracting with the die, it should be again annealed, in order to regain the requisite amount of ductility.

Now we come to the most important part. What is the best material for the thimble? If we use copper, what thickness should it be? That depends not only on the diameter of the flue, but on the diameter of the flue-hole as well. The point I wish to make is this: That when the flue is fastened in the flue sheet it should not be expanded beyond its original diameter. Taking this into consideration, it is a very easy matter to determine the thickness of the thimble.

Acting on this principle, I found that where I could arrange to use copper about $\frac{1}{16}$ in. thick, which is No. 18, it gave the best results. Where a thicker thimble is used, the flue has to be expanded too much to make it tight enough. Copper being of a soft, yielding nature, it is liable to crush out before it is compressed sufficiently between the flue and the sheet; also, by the use of too much soft metal, the strain the flue is subjected to from boiler pressure, or from the sudden contraction of the metal, is more likely to loosen the flue in the sheet than where a thinner thimble is used.

There seems to be a difference of opinion as to whether it is necessary to bead the flue at the smokebox end. I claim that it is just as necessary to bead it at the smokebox end as at the firebox end. Calking, or beading the end of the flue, when properly done, adds strength to it after it is expanded, and assists it in retaining its hold in the sheet when exposed to expansion or contraction. When calking or beading is improperly done, it is detrimental to the life of the flue; in fact, if care is not taken, there is liability to undo, to some extent, what has already been done, in other words, to loosen the flue in the sheet. To calk or bead a flue properly, it should, during the process, be held rigidly in the position to which it has been expanded; for in calking, the blow is transmitted longitudinally instead of laterally. In order to meet these requirements, my practice was to use plugs or mandrels which were slightly tapered; these were driven into the ends of the flue at the same time, and the ends were calked or beaded around them. I am opposed to the use of what is commonly called the heel tool, which is so extensively used at the present time, as I firmly believe it does more harm than good.

Bad water is a common cause of leaky flues. It is a well known fact that the largest amount of incrustation is developed on the lower flues, while the upper ones will be comparatively clean and free from it. The result is unequal expansion; the flues become what is commonly called mud burnt; the ends will chip or break off, and the flue becomes loose in the sheet. This trouble can to a great extent be obviated by washing the boiler out thoroughly and as often as necessary in order to prevent incrustation with all its attendant evils. When flues are covered with incrustation and commence to leak, if you endeavor to stop them by expanding, rolling or calking, the chances are ten to one that you will have to repeat the dose before the engine has made two trips over the road. I believe the only remedy for flues in that condition is to take them out, clean them and reset them.

A reprehensible practice is running with the furnace door open, allowing cold air to pass through the flues; this will very soon cause them to leak. The furnace door was not made or ever intended to be used as a damper. Engineers should avoid as much as possible pumping water into the boiler when not using steam; in fact, they should guard against anything that has a tendency to cool off the flues suddenly, thereby causing a sudden contraction of the metal while under pressure. The engineer should see that the flues do not get stopped up with ashes and dirt; when forty or fifty flues get choked up, the process of boring them out is liable to start them leaking. When flues are in this condition the fireman has to work a great deal harder to keep up steam, and the harder he has to work, the more fuel he wastes.

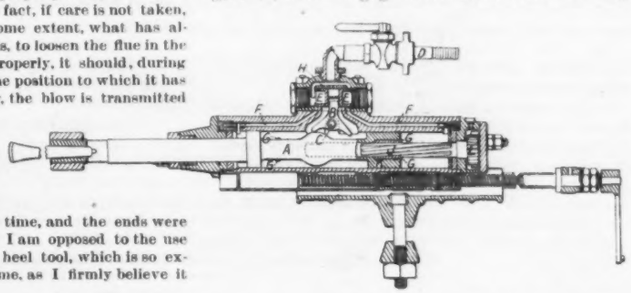
DISCUSSION.

In answer to a question, Mr. STINARD said the tool he used for beading with a mandrel in the flue was a half round tool of the style used years ago for copper flues. Before calking the flue can be driven out of the sheet with a light blow, and the ordinary heel tool certainly loosens the flue in the sheet.

Mr. G. W. WEST inquired if this was true why there was so little trouble with the smokebox end of the flues. He never beaded the flues at this end and there was never leakage there. He had used copper liners at the firebox end since the discussion at the last meeting (See ENG. NEWS, Sept. 26) and thought the engine had already run longer than before. As to material, he purchased two grades of flues, and in building one engine put the best flues on one side and the cheapest on the other. The fireman and every engineer that ran the engine said he has seen no difference between them; both kinds of flues are just beginning to leak. He approved Mr. STINARD'S idea that the flue might be too hard as well as too soft. His experience had been that the leakage of flues was due to the contraction of the flue rather than to the expansion of the flue sheet.

The Rio-Tinto Rock Drill.

This is a compressed-air rock drill invented by Mr. JAMES MCCULLOCH, of England, and extensively used by him for about three years at the Rio-Tinto mines, in Spain, for tunneling and quarry work. The special feature of this drill is the operation of its distributing valve. In the accompanying cut, *A* is the piston rod, the rear end of which is hollow, and the enlarged portion of which, in its reciprocating motion, moves the tappet *B*. The tappet is pivoted to the cylinder at *C*, and the upper arm operates the piston valve *D*. The compressed air supplied through the pipe *E* is thus caused to pass through the passages or ports, *FF*, to each end of the cylinder alternately. The exhaust holes are shown at *GG*. The valve works in the chamber *H*, in the top of which is an air hole. At each end of the chamber is a steel disk faced with india rubber, against which the valve is held by the tappet and air pressure. The valve can be reversed when worn, and what was the upper part then engages with the tappet arm. On the inside of the cylinder is the guide spindle *J*, having spiral grooves, which engage with feathers on the bush



"Rio Tinto" Rock Drill: James McCulloch, Inventor.

K in the hollow of the piston rod. This guide spindle has a ratchet wheel *L*, with pawls actuated by springs. These pawls hold the wheel on the outward or cutting stroke, a rotary or angular motion being then given to the pistons, rod and drill by the bush sliding on the spindle. On the return stroke the pawls do not engage with the ratchet wheel, and the spindle is therefore free to revolve. The feed of the drill is regulated by the long screw under the cylinder, which is carried in bearings in the bracket and in V-shaped projections on the cylinder which slide in corresponding grooves in the bracket.

The inventor states that the distributing valves of rock drills have in some instances been operated by means of a tappet actuated by the motion of the piston or piston rod, but that in such cases it has been necessary to use a spring for retaining the valve in position at either extremity of its stroke, while not acted upon by the piston or rod. Considerable inconvenience has been caused by the failure of the spring, owing to the loss of its strength or the friction caused by excessive tightening of the spring. In other instances the valves have been operated by air pressure, but this arrangement is unreliable, as the valve is apt to flutter or stick, or to be rendered inoperative by the entrance of sand, grit, etc., between the working faces, in which case the air pressure is insufficient to overcome the increased resistance to the movement of the valve. The springs are also said to offer great resistance to the movement of the working parts, and when these are slightly worn the valve is not kept in its proper place, and the apparatus will not work properly until the springs are renewed or readjusted. This leads to much trouble and inconvenience, especially when working underground. In the valveless machine, too, the motive fluid is in constant communication with the piston, thereby causing great resistance to working and waste of fluid. The Rio-Tinto drill is claimed to obviate these defects, and is provided for operating the valve by the combined action of a tappet and fluid pressure. Other patented improvements have also been introduced.

In this drill the air or fluid delivered through the supply pipe is forced by the valve to pass to each end of the cylinder, where it expands, and is then discharged through the exhaust holes. Atmospheric air then enters through these holes, and is compressed at each end of the stroke, thus cushioning the piston, while its expansion on the return stroke increases the power or initial pressure tending to move it. On the outward or cutting stroke, this cushioning does not offer any appreciable resistance to the force of the drill except when the pistons travel too far, as when the drill strikes soft places in the rock, or when the machine is not kept in its proper working position. The atmospheric air is prevented from entering the compressed air supply passages by means of small valves, as shown in the cut. The valve in front of the moving piston is closed by the cushioning, while the valve behind is opened by the higher pressure of the compressed air. When the main distributing valve is at either end of its stroke, the compressed air or other fluid holds it in position and prevents any movement while the enlargement of the piston rod is out of contact with the tappet.

The Rio-Tinto drill is patented in this country and was awarded the first prize at the Mining and Metallurgical Exhibition in London, 1890. The patentee's agents are Morrison, Kekewich & Co., of London, England.

Boiler Inspection.

A paper on this topic was read by Mr. C. A. SELEY at the last meeting of the Northwest Railway Club. He quoted the U. S. Government rules for the inspection and test of marine boilers, which require annual inspection and hydrostatic test at a pressure 1½ times the steam pressure carried. Hydrostatic testing to this limit has not been generally practiced on railways; but the author believed the usual custom of testing with a pressure only 10 or 15 lbs. in excess of the working pressure was wrong. The excess of pressure used in testing ought to be sufficient to cover possible wear, corrosion, grooving, &c., likely to develop in the 18 to 24 months before the engine comes around to the sho It is complained that high test pressures strain the flat stayed surfaces of locomotive boilers; but marine boilers also have flat surfaces and do not seem to suffer from the tests. The author has for two years tested all sorts of stationary and portable boilers for the state of Minnesota. The same excess of pressure is used as in the U. S. Government tests, and this has been done for six years without an instance of a boiler's giving way as a result of overstrain in testing.

It is true that where a boiler can be thoroughly inspected in all parts, inside and out, there is less need for hydrostatic testing; but parts of a locomotive boiler are inaccessible. On the other hand inspection is needed both during and after a test. A stay-bolt or brace which gives way during a test will make a loud report; but if it had already separated, an internal examination after the test will be required to disclose the fact. It is a good idea to place all the boiler testing on a railway line in special hands. This will facilitate uniformity of records, and will make much easier the deduction of valuable lessons from the records obtained.

The author also alluded to the need of greater care in protecting boilers from strains due to unequal expansion. Cracked side-sheets, leaky mud rings and loose tubes are in a great measure due to the manner of laying up the locomotive after a trip. If the fire must be drawn at the end of a trip, there ought to be some method of stopping entirely the circulation of air through the tubes and the rapid cooling off of the boiler. On some locomotives in Minneapolis the fires are kept banked when the engine is out of service, and are never put out from one week's end to another. These engines are said to require almost no repairs on the fire-box and tubes.

The Comparative Merits of Various Systems of Car Lighting.

(*Continued from page 581*).

by multipling the value of each ray in candle-powers by the coefficients $Cos^2\ D$, which are as follows:

D.	Cos D.	$Cos^2\ D$.	Angle from horiz.
0°	1.	1.	90°
10°	.9848	.9698	80°
20°	.9397	.8830	70°
30°	.8563	.7500	60°
40°	.7660	.5868	50°
50°	.6472	.4189	40°
60°	.5000	.2500	30°
70°	.3420	.1170	20°
80°	.1736	.0301	10°
90°	.0000	.0000	0°

These coefficients (between the rules above) are given at the end of Table I., showing the observed candle-power of the several rays of each light tested. The recorded candle-power, multiplied by these coefficients, gave the table of visual units in Table II. From this Table II. of visual units the diagram shown in Fig. 9 was constructed, which shows the distribution and number of the visual units from a single lamp *striking on a plane perpendicular to the ray* along the horizontal visual plane.

TABLE II.—VALUE IN "VISUAL UNITS" (ONE C. P. SHOWN AT A DISTANCE OF 4.5 FT.) OF THE LIGHTS SHOWN IN TABLE I. IN A HORIZONTAL PLANE 4.5 FT. BELOW LIGHT. LIGHT ASSUMED TO STRIKE A PLANE NORMAL TO THE RAYS (HEADINGS TO COLUMNS SAME AS TABLE I.).

Hz) deg									
10°	1.6	2.2	3.0	1.4	1.5	1.2	2.5	1.4	1.2
20°	6.2	8.4	7.7	5.4	5.9	5.1	9.8	5.0	4.8
30°	10.6	13.0	16.1	9.0	11.3	12.3	20.4	9.0	7.5
40°	17.6	21.4	23.8	14.9	19.0	22.6	35.5	12.6	10.2
50°	17.8	24.0	34.7	18.8	24.2	32.2	46.5	15.8	11.4
60°	14.6	25.2	52.6	32.1	30.9	38.6	59.9	8.1	12.8
70°	9.6	19.8	55.3	43.5	36.3	47.2	62.8	6.5	9.8
80°	3.6	19.2	59.8	36.6	34.6	51.9	69.0	4.9	6.4
90°	2.4	18.4	52.5	34.9	40.3	55.5	74.4	4.8	4.5

From Table II. the diagram (Fig. 9) showing value in visual units of the several illuminants is constructed.

From this diagram (Fig. 9) alone much information of value can be had, which is not to be had from candle-power diagrams alone, and some of which we shall shortly note; but to derive all the advantage which may be had, three other facts must be considered, and two (at least) other diagrams constructed from it, as given in Figs. 10 and 11. These facts are:

1. The light derived from lights which the passenger faces is worthless to him, or worse than worthless; it makes it harder rather than easier to read or see about the car. In less degree this applies to the rays coming vertically downward, because:

2. A book or other object in the usual plane on which light is needed cannot be held so as to be perpendicular to all the rays which reach it from a series of lamps, and it is naturally held at an angle of about 45° to the vertical.

The *full* value in visual units, therefore, is realizable and realized only from rays at an angle of 45°, perpendicular to a plane at an angle of 45° with the horizontal. The value of all other rays which strike this surface is diminished as the *cosine* of the angular deviation of the ray from 45° is to 1. The little table of cosines above, however, will show that until this deviation exceeds about 25°, in other words, for rays at all angles between 20° and 70° (inclusive) with the horizontal the loss from this obliquity of angle is not material, so that all rays lying within those angles may be taken to have their full illuminating value in visual units, although only one of these rays can strike the surface of a book precisely perpendicular thereto. On the other hand, rays striking the book within 20° of the horizontal or vertical must have their unit value in visual units diminished. But to do this is a comparatively simple matter, because:

3. The seats in a car are usually spaced about 3 ft. apart, and the lights either 6 ft. or 9 ft. apart, or 2 to 3 seats. In a sleeping car the seats are placed back to back, that is all. There are many variations in the spacing of both lights and seats, but the variations outside of the above limits are too small and few to be of moment.

This being so, the interior view of a car shown at the top of Fig. 10—which is modified from a drawing of a standard Pennsylvania R. R. passenger car fitted with the Frost carbureter (gasoline) light—will at once make clear: 1. That all the rays striking the visual plane of any seat from any lights in the car, strike it within the limits of 20° and 70°, and consequently may be taken at their full value in visual units, *excepting* the rays from a light which is directly over a seat, or nearly so. These rays strike the surface to be illuminated in the visual plane at an angle of about 45°, and consequently their value in visual units must be multiplied by Cos 45° (.7071, taken as 0.7 as a sufficiently exact approximation) to get their true illuminating value.

This being determined, we may deduce from Fig. 9, which gives the value in visual units at any point along the visual plane of the rays from a single light of the various kinds tested, the total *useful* value of the light reaching any seat from all the lights in a car, spaced in any way devised. This is done in Table III., the results of which are plotted in Figs. 10, 11.

For example, take lights spaced 6 ft. or 2 seats apart, and the seat directly under a light. It is illuminated by (1) the light directly overhead, (2) by

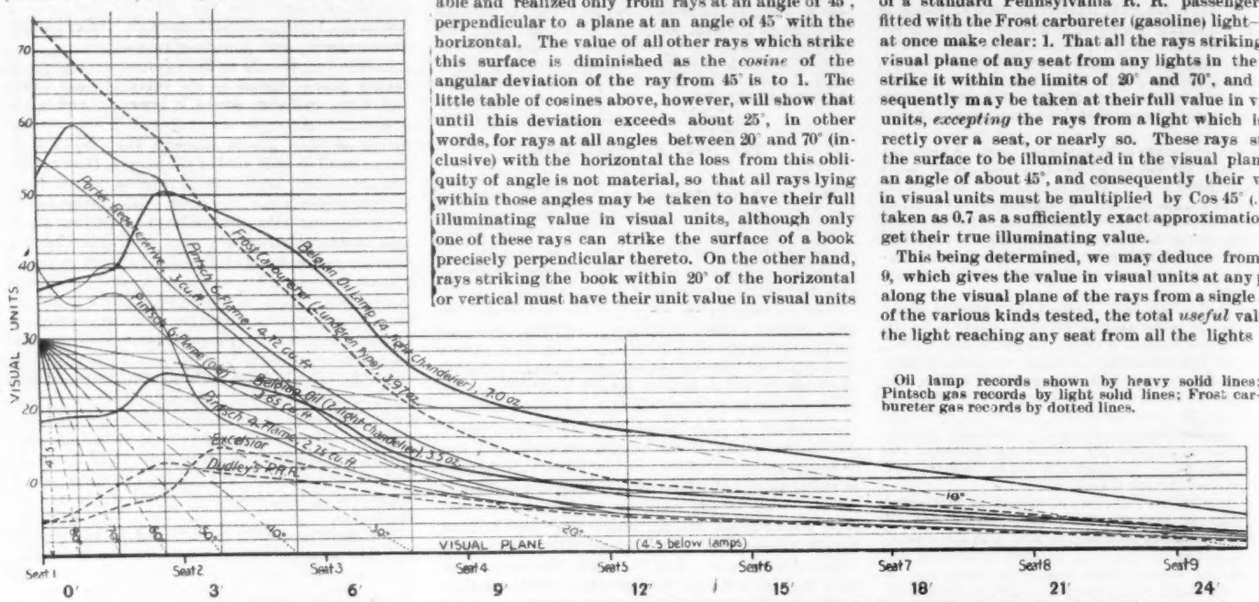


FIG 9. DIAGRAM SHOWING THE VISUAL UNITS (1 C. P. AT A DISTANCE OF 4.5 FT.) SUPPLIED TO EVERY POINT ON THE VISUAL PLANE (4.5 FT. BELOW THE LAMP, SEE FIG. 10) BY ONE LAMP OR CHANDELIER OF EACH KIND TESTED.

[Light supposed to be received on a plane held in the visual plane perpendicular to each ray.]

Oil lamp records shown by heavy solid lines; Pintsch gas records by light solid lines; Frost carbureter gas records by dotted lines.

TABLE III.—VISUAL UNITS (1 CANDLE-POWER AT A DISTANCE OF 4.5 FT.) STRIKING A BOOK HELD AT AN ANGLE OF 45 DEGREES BY AN OCCUPANT OF EACH SEAT IN THE CAR, WITH VARIOUS LAMPS OR CHANDELIERS, SPACED 6 FT. AND 9 FT. APART.

[From this table Figs. 10 and 11 were constructed.]

	Two Belgian oil lamp chandeliers, with shade.	Pintsch gas.				Frost carbureters.		
		Present 6-flame.	Present 4-flame.	Old 6-flame.	Porter Regen'tve.	Present Lundgren.	Old Excelsior.	Old Dudley "P. R. R."
Fuel per hour	3.5 oz.	4.72 cu. ft.	2.75 cu. ft.	3.65 cu. ft.	3.00 cu. ft.	3.97 oz.	2¼ oz. ±	2¼ oz. ±
LIGHTS SPACED 6 FT. APART—FIG. 10.								
Seat under lamp.								
From lamp overhead x .7	6.5	37.2	24.7	28.5	39.2	52.6	3.4	3.2
" " 6 ft. back	19.5	28.2	13.3	17.2	19.2	31.9	11.7	9.0
" " 12 " "	8.8	8.1	5.2	6.0	5.4	10.0	5.2	5.6
" " 18 " "	5.9	5.2	3.6	4.0	4.0	6.6	3.6	3.5
" " 24 " "	3.0	2.8	1.7	2.0	1.7	3.2	1.7	1.7
Total	43.7	76.5	48.5	57.7	69.5	104.3	25.6	23.0
Seat between lamps								
From lamp 3 ft. back	24.9	47.5	26.6	28.4	36.0	53.5	10.8	12.5
" " 9 " "	11.4	12.7	7.8	9.5	10.0	16.3	7.8	6.6
" " 15 " "	7.2	6.6	4.0	4.9	4.2	8.1	4.0	4.0
" " 21 " "	4.3	3.9	2.5	3.0	2.5	4.9	2.5	2.5
Total	47.8	70.7	40.9	45.8	52.7	82.8	25.1	25.6
Mean visual units of both seats	45.7	73.6	44.7	51.7	61.1	93.5	25.3	24.3
LIGHTS SPACED 9 FT. APART—FIG. 11.								
Seat under lamp.								
From lamp overhead x .7	6.5	37.2	24.7	28.5	39.2	52.6	3.4	3.2
" " 9 ft. back	11.2	12.7	7.8	9.6	10.0	16.2	7.8	6.8
" " 18 " "	5.9	5.2	3.6	4.0	4.0	6.6	3.6	3.6
" " 27 " "	2.0	1.8	1.3	1.4	1.1	2.3	1.3	1.1
Total	25.6	56.9	37.4	43.5	54.3	77.7	16.1	14.7
First seat back of lamp.								
From lamp 6 ft. back	19.5	28.2	13.3	17.2	19.2	31.9	11.7	9.5
" " 15 " "	7.2	6.6	4.0	4.9	4.2	8.1	4.0	4.0
" " 24 " "	3.0	2.8	1.7	2.0	1.7	3.2	1.7	1.7
Total	29.7	32.6	19.0	24.1	25.1	43.2	17.4	15.2
Second seat back of lamp.								
From lamp 3 ft. back	24.9	47.5	26.6	28.4	36.0	53.5	10.8	12.5
" " 12 " "	8.8	8.1	5.2	6.0	5.4	10.6	5.2	5.0
" " 21 " "	4.3	3.9	2.5	3.0	2.5	4.9	2.5	2.5
Total	38.0	59.5	34.3	37.4	43.9	69.4	18.5	20.0
Mean visual units of the three seats	31.1	49.7	30.2	35.0	41.1	63.1	17.3	16.6

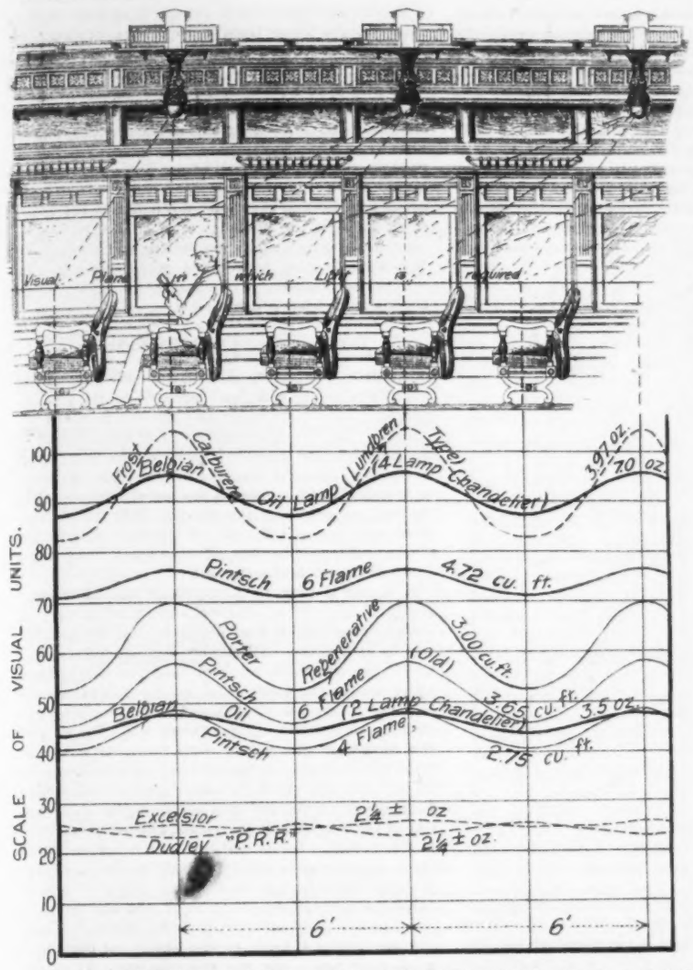

Visual Plane on which Light is required
SCALE OF VISUAL UNITS.
Frost Carbureter Oil Lamp (Lundbren Type) (4 Lamp Chandelier) 3.97 oz. 3.70 oz.
Pintsch 6 Flame 4.72 cu. ft.
Porter Regenerative (Old) 3.00 cu. ft.
Pintsch 6 Flame (2 Lamp Chandelier) 3.65 cu. ft. 3.5 oz.
Belgian Oil Pintsch 4 Flame, 2.75 cu. ft.
Excelsior 2¼ ± oz
Dudley "P.R.R." 2¼ ± oz
6' 6'

FIG. 10. POSITION OF VISUAL PLANE AND TOTAL VISUAL UNITS SUPPLIED BY **ALL** THE LIGHTS IN A CAR TO EACH SEAT THEREIN, WITH LIGHTS **6** FT. APART.

[The visual units being for effective light delivered perpendicular to the pages of a book in the hands of a passenger.]

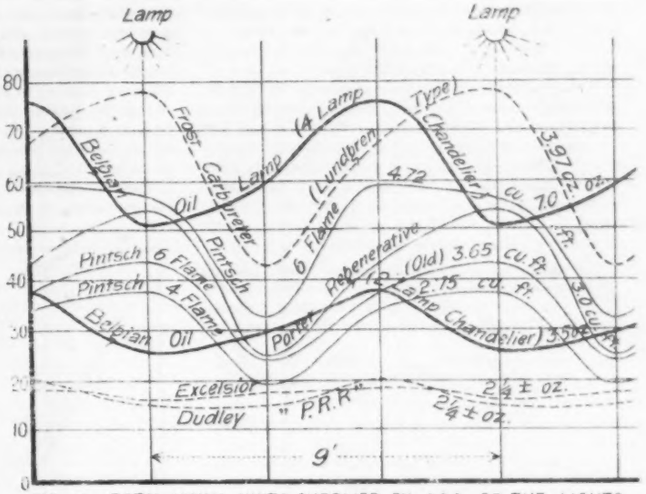


FIG. 11. TOTAL VISUAL UNITS SUPPLIED BY **ALL** OF THE LIGHTS IN A CAR TO EACH SEAT THEREIN, WITH LIGHTS **9** FT. APART.

[The visual units being for effective light delivered perpendicular to the plane of a book in the hands of a passenger.]

a light 6 ft. back, (3) by one 12 ft. back, and so on indefinitely.

We first read from Fig. 9 the value in visual units of the vertical rays: These are to be multiplied by 0.7 to get their visual value.

Then, on the vertical line marked 6 ft., Fig. 9, we can read off the value of the light reaching the same seat from a light 6 ft. back; from the vertical lin marked 12 we get the value to the same seat of the lamp 12 ft. back; from the vertical line marked 18, we get the value to the seat of the next line, 18 ft. back, and so on. The value in visual units dimin ishes so rapidly that lights more than 15 to 18 ft. back have little effect on the total, as will be seen in Table III., which was thus compiled. It gives for each kind of light tested and for each car-seat between lights spaced either 6 ft. or 9 ft. apart, the light from *each* lamp or burner in the car which contributes a sensible amount of useful light to it, which are the lights between a point vertically over it and 27 ft. back of it; the visual units of vertical rays, as read off from Fig. 9, are first multiplied by the coefficient 0.7 as recorded above, and all the other readings from Fig. 9, for lamps 3 ft. or more behind the seat, are recorded as read off.

The total of these illuminations from all the lamps within 27 ft. of a seat gives, within a trifling margin of error, which does not affect comparisons, the *total useful illumination striking each seat in a car from all the lights therein, in effective visual units;* or in other words it gives the number of candle powers at a distance of 4.5 ft. necessary to give the same light for reading, etc., with the rays striking perpendicular to the pages of a book or other sur face as ordinarily held.

Of course these diagrams (Figs. 10, 11) apply with precision to such seats only as are fortunate enough to have a series of 3 to 5 lights behind them. Seats toward the back end of the car receive less light; but the amount of light derived from lamps more than 6 to 9 ft. back of a seat is so small that practically the diagrams may be regarded as applying to all the seats.

Such diagrams have never before been constructed or attempted, and we need hardly say that they illustrate certain truths as to car-lighting of no small importance, which it is well to bring out in definite form. As one point of especial importance they show that neither the horizontal nor vertical rays are of much real use. The perfect light as regards distribution should minimize these rays, and put as much of the light as possible into the rays lying between the angles of 20° and 70°.

The most conspicuously successful of the lights in this respect are the two old Pennsylvania standard burners for the Frost carbureter system known and marked as the "Dudley P. R. R. standard" and the "Excelsior." Both of these lamps not only put the light where it does most good, but produce a substantially perfect and uniform distribution of the light in the visual plane, whether the lamps be placed 6 ft. or 9 ft. apart. As a consequence, although the total volume of light throughout will be seen to be comparatively trifling, yet they were felt to give a very satisfactory illumination, by no means so inferior to the new inverted burners as the candle-power diagrams indicate at first sight.

Next to these in evenness and excellence of distribution, and far ahead of them in total visual units of light, come the 2-flame and 4-flame Belgian lamp chandeliers. The Belgian lamp was described in our issue of Nov. 10, and the results obtained from it are taken as representing the best present practice in car lighting with oil lamps.

It should be mentioned that in testing all the oil lamps only a single lamp was burned, as the nature of the photometric apparatus requires, and the power of a 2-lamp or 4-lamp chandelier was obtained by multiplying the candle-power of one lamp by the number of lamps. This is not quite exact theoretically; but is sufficiently accurate for practical purposes.

A more important consideration is that the candle-power of any oil lamp is greatly affected by the skill and care used in managing it—adjusting the wick, etc.—so that an oil lamp under test is likely to show considerably more candle power than will the average of a hundred burned as in service. In far less degree, all the systems of gas lighting show less candle power in daily service than under the skilled manipulation given them while under test. The Pintsch gas burners require occasional brushing and cleaning. The Frost gasoline system varies with the richness of the vapor burned, and requires about the same watchfulness while burning as an oil lamp, but does not fluctuate nearly so much in candle power. Even the electric lamps show great variation with slight alterations in current and with the age of the lamps. But no system of gas or electric lighting has any constantly variable element in it comparable with the condition of the wick in oil lamps.

The two gaslight systems tested are both defective in *distribution* of light. Much of the light is wasted on the carpet and the walls of the car without doing any sensible good. The Frost carbureter light is the most defective of the two in this respect, and the Pintsch light least so; but it is possible that the makers of both may get a useful hint from these diagrams, and by making slight changes in the form of the reflecting surfaces may get a much more *effective* light, distributed as in Fig. 13, from the same candle power and gas consumption.

We have spoken of the light thrown on the carpet or walls of the car as "wasted." This may be questioned on the ground that the light is reflected back into the car and becomes useful, but we believe it to be a substantially truthful expression.

A pretty accurate evidence of the real value of this reflected light may be obtained by comparison of the tests of the Belgian lamp with a shade and without one. Without a shade, the average semicircular candle power of the lower semicircle will be seen from Table I to have been (for 2 lamps) 31.82 c. p. Directly under the lamp the candle power was all most nothing, owing to the obscuring effect of the lamp body, and examination of the first column of Table I will make it clear that the probable mean candle power of the upper semicircle was 45 c. p. at least.

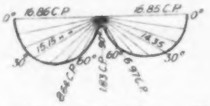
The shade used was an ordinary conical porcelain shade, which is a vastly better reflecting surface than the carpet or walls of the car, and had the effect to throw all the 45 c. p. of the upper semicircle downward, so far as effective reflection was possible. How much was added in this way to the total candle power of the lower semicircle? It was increased only from 31.82 to 45.47 c. p., a gain of 13.65 c. p., or less than 43%, only 30⅓% of the light in the upper semicircle being effectively reflected. If a porcelain shade cannot do more than this in the

way of saving light by reflection, it is a perfectly reasonable assumption that hardly an eighth or tenth of the light is effectively reflected from the walls, and none at all from the floor.

It may be claimed that this otherwise lost light is of value, nevertheless, in giving a general air of brightness and cheerfulness to the car, but this also may well be questioned. A universal glare is not pleasant in any room where one wishes to read. Plenty of light on the book and as little as possible (within limits) elsewhere is the preferable distribution.

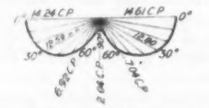
THE CANDLE POWER OF ELECTRIC LAMPS.

The ordinary incandescent lamps used for car lighting are nominally of 16 candle power; practically, however, the light given off in different planes varies as greatly with them as with the lights

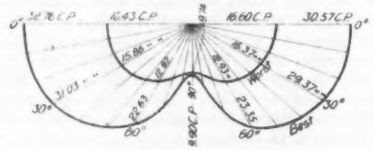


Edison, New, 110 Volts, 56 07 Watts. Watts Per Mean Spherical c. p. = 4 070.

Edison, 93 Volts, 67.33 Watts. Watts Per Mean Spherical c. p. = 5.325.



Edison, 85 Volts, 52.70 Watts. Watts Per Mean Spherical c. p. = 5 044.



Weston, 110 Volts, 70.97 Watts. Watts Per Mean Spherical c. p. = 3.466.

(This diagram shows two sets of measurements, one taken in same plane as filament, the second taken at right angles to it.)

Sawyer-Man, 110 Volts, 73.97 Watts. Watts Per Mean Spherical c. p. = 3.174.

Sawyer-Man, 60 Volts, 57. Watts. Watts Per Mean Spherical c. p. = 3.004.

FIG. 12. CANDLE POWER TESTS OF INCANDESCENT ELECTRIC LAMPS.

described above. In order that comparisons may be easily made, we have drawn diagrams* of the candle power of various electric lamps on the same scale as the diagrams above.

It is evident from these diagrams that the electric light is among the best in distributing the light given out where it will do the most good. But the fact of greatest practical interest to railway managers who propose to try electric lighting is that the volume of light varies greatly with the kind of lamp used. Every one of the lamps whose candle power diagram is given in Fig. 12 is called by its makers a 16 candle power lamp; yet the actual volume of light is in some of these lamps double what it is in others; and the efficiency, or the amount of light given out for a given consumption of energy, varies also nearly one-half. Another point of interest is the variation in the light given off by the lamp in

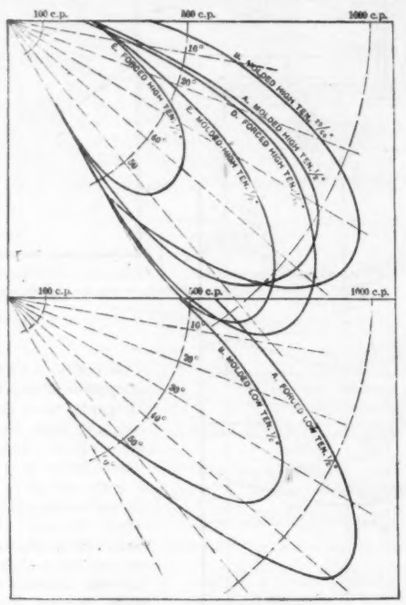

100 c.p.
500 c.p.
1000 c.p.
C. MOLDED HIGH TEN. ½"
A. MOLDED HIGH TEN. ½"
E. FORCED HIGH TEN. ½"
B. MOLDED HIGH TEN. ½"
D. FORCED HIGH TEN. ½"
B. MOLDED LOW TEN. ½"
A. FORCED LOW TEN. ½"

Fig. 13. Candle Power Tests of an Electric Arc Light, Using Various Carbons.

different vertical planes. In most of the lamps tested this variation is not great, but in the Weston lamp the light given off in the plane of the filament is only about half that given off in the plane at right angles to it. The difference in the available light is well shown by the diagram.

It is of interest to compare the amount of light given out by these incandescent lamps with the light furnished by an electric arc lamp, shown by diagrams in Fig. 13. Necessarily these diagrams are plotted on a different scale from those preceding. If they were plotted on the same scale, a sheet would be required over 6 ft. wide, for the radial line representing the maximum candle power would be about 40 ins. long.

We are indebted for these arc light diagrams to a paper by Mr. LOUIS B. MARKS on "The Life and Efficiency of Arc Light Carbons" (Trans. Am. Inst. Elec. Engrs., Vol VII.; p. 175). While the effect of the structure of the carbons upon the light was the chief object of the author's investigation, accurate photometric measurements of an arc light using the various carbons were necessary. The carbons used were from five different makers, designated A, B, C, D, E. Some of them were intended for high tension currents and others for low tension; and some of them were made by the "forcing" process (the plastic material being "squirted" through a die), while others were molded carbons.

For high tension carbons a current of 9 amperes was used, and the difference of potential between the lamp terminals was kept at 45 volts. Hence the electrical energy absorbed was $9 = 45 = 405$ watts $= 0.543$ electrical HP. For low-tension carbons the current used was 21.5 amperes, with a drop in potential of 30 volts. Hence the energy absorbed was $21.5 = 30 = 645$ watts $= 0.87$ electrical HP. The average result in efficiency, with each kind of carbon, is given as follows:

Kind of carbon.	Watts per spherical c. p.
A. Molded, high tension	0 888
D. Forced, high tension	0.883
B. Unplated, molded, high tension	0.771
E. Molded, high tension	0.953
E. Forced, high tension	1.497
A. Forced, low tension	1.25
B. Molded, low tension	1.612

It is of especial interest to note that while in the incandescent lamp from 3 to 5 watts of electrical energy are absorbed for each candle power of light produced, the arc light generates a candle power with only ⅝ to 1½ watts. In larger units, one horse power of electrical energy produces in the incandescent lamp 150 to 250 c. p.; and in the arc lamp, 500 to 1,000 c. p. This fact, that the electric current is used in the arc light with four times as great efficiency as in the incandescent light, gives good ground for hoping that some method may yet be devised whereby the efficiency of small electric lamps, suitable for interior lighting, will be much increased. When this is done, as we have before pointed out, electric car lighting will stand on quite a different footing from what it does to-day.

Tar Pavements and Tar Varnish.

Notwithstanding the many uses which have been found for tar, the constant increase in its production has made it a drug in the market in many localities. In the manufacture of oil gas for railway car lighting, for instance, some works burn their tar under the gas retorts, finding this the most economical and convenient method of disposing of it. At the gas works of the Central Railroad of New Jersey, in Jersey City, we are informed that the tar is run into an old tender, which is hauled out when full and the tar is run to waste.

It seems a pity to see material wasted which is really of such value; and while the uses of tar are already manifold, it does not seem that the possibilities in its use are sufficiently appreciated by engineers. Our attention has been called to this subject by an interesting paper read at the recent annual meeting of the American Gas Light Association by Mr. DAVID DOUGLAS of Savannah, Ga. Up to 1888 the Savannah gas works were using naphtha and other distilled oils for gas making, and the quantity of tar was too small to make account of. When Lima crude oil was put into use, however, the quantity of tar was greatly increased, and some method had to be found for its disposal. To bring the crude tar to a proper consistency for sale it was distilled, yeilding about 8½% of water, and 44½% of oils of various degrees of specific gravity, the lighter ones being pretty good solvents for india rubber. These oils are pumped back to the crude oil tank, and used over again for gas manufacture. It is the pitch remaining after distillation which must be disposed of. Mr. DOUGLAS described his attempts to create a market for the tar as follows:

As we had not been making tar for sale for some years, the demand for the tar when made was at first very slow. I, therefore began some experiments in the manufacture of an asphalt which could be used for sidewalks and light pavements, hoping thus to make a market for the tar. I investigated the formulas of as many manufacturers of asphalt as I could get. The best of them, so far as I could judge, used varying proportions of refined Trinidad asphaltum, heavy petroleum oils, pulverized carbonate of lime and sand.

A proportion of partly distilled coal tar was used in some instances, but my idea was that none of the manufacturers cared to impress probable purchasers with the idea that coal tar was largely used in their material.

It seemed to me that prepared water gas tar was about as good a substance as Trinidad asphaltum, and by stopping the distillation at the proper stage there need be no subsequent addition of heavy oils. I had a pretty good substitute for pulverized carbonate of lime at hand in the form of gas lime, and sand is abundant.

The making of a fine street asphalt was not contemplated. My efforts were to make a cheap asphalt which could be mixed in the gas works yard and hauled out and laid anywhere when cold. I proposed to have the article ready mixed in the yard and sell it by the ton to such as might have occasion to use it. As resin is a cheap article in Savannah, I was tempted to use some of it, because it stiffened the tar and saved time in the distillation. I do not, however, recommend its use. It is an inferior material and detrimental to the durability of anything it is mixed with.

After many trials and failures, I at last produced a very fair asphalt which answers the purpose. Its composition was:

	Per cent.		Lbs. per ton.
Tar	20	=	400
Resin	10	=	200
Gas lime	50	=	1,000
Screened ashes	20	=	400

The gas lime and ashes had to be heated and the resin and tar melted together, and a thorough mixing was essential. A better article could be made by using sand

* The photometric measurements from which these diagrams are plotted were made by Messrs. H. M. HOBART and E. W. GANNETT in the Laboratory of the Massachusetts Institute of Technology, and were reported by WM. L. PUFFER in the *Technology Quarterly* for May, 1890.

instead of ashes, or even a proportion of sand, but sand cost something, and I had plenty of ashes in the yard.

I got an order from the city authorities for a trial lot. They graded the ground very nicely with oyster shells, well rolled. One ton of the asphalt covered 25 sq. yds. of surface, and it was fit to walk upon as soon as it was rolled firm and smooth. The work was perfectly satisfactory, and I received further orders at a fair price, but it was evident that we were not making enough tar to meet anything like the amount of business which could be developed in this direction. The demand for tar in other directions improved, and I abandoned the asphalt business.

While examining this tar during my experiments I was attracted by its beautiful glossy black appearance. It seemed to be almost free from lamp black. The thickened tar was exceedingly viscous, and could be drawn out into threads as fine as silk when lifted on the end of a stick. Every indication showed it to be of a superior quality to coal tar. A recent analysis of water gas tar, made by Dr. WOODMAN, of New York, gave 4½% of lamp black.

I felt all along that this water gas tar is of too good a quality to be used only for such rough purposes as coal gas tar is generally applied to, so I turned my attention to making a black varnish which would bring a higher price for my tar than if sold simply as tar. What I sought to make was a bright glossy varnish which would dry reasonably quickly, and when dry would not scale off, but would retain a certain amount of plasticity without becoming tacky under a little excess of heat. I think we at last managed to make a pretty good material.

We use this varnish for our gas meters, and find it superior to anything we had been in the habit of purchasing. I also sell it for coating cotton ties, *i. e.*, the hoop-iron bands which bind the cotton bales. These are subjected to a good deal of strain and twisting. If they rust they are apt to stain the cotton, and if they are tacky the men would object to use them. This varnish quite fills their requirements, and they say is better than the regular asphaltum varnish they had been using hitherto.

My formula for this paint is very simple, but I think I tried every kind of mixture before I got it.

In distilling the tar we run long enough to get rid of some of the heavy oils, leaving the tar pretty thick. Take crude rubber and dissolve it in some of the lighter distillates from the tar. Mix the dissolved rubber with the heavy tar, adding enough light distillates to thin the mixture to a proper consistency to work easily with the brush. Half a pound of rubber is sufficient for 50 galls. of varnish.

In answer to further questions, Mr. Douglas stated that the pavement above described was used for sidewalks only and had been laid now nearly two years in streets where there was a great deal of travel, and was perfectly good.

The varnish he describes must certainly be exceedingly cheap, and if good enough for cotton ties ought to be good enough for almost any use for which asphaltum varnish is now employed. There is little doubt that material of this class is far more durable in protecting iron work from corrosion than any kind of paint; and its use is preferable wherever the circumstances admit.

The Alleged Waterways on the Planet Mars.

From the *Deutsche Bauzeitung* we abstract the following alleged information in regard to the supposed great canals in the planet Mars, which we illustrated and described in our issue of May 18, 1889:

As in the years 1892, 1894 and 1896, the above planet will reach its closest approach to our earth, we may expect some highly interesting facts concerning that body. It seems proper to note that similar conditions to ours must be prevailing there, and that the inhabitants of that planet seem to be admirable constructors of water-ways of immense dimensions, as they seem to be able to control the ocean itself there. Mars is computed to be 5,000,000 years older than our own planet [by whom or by what means is not stated. ED.], so that in about that time the disintegrating process caused by the force of nature here will be so far advanced as to nearly level our mountains. No more natural rivers will be flowing, and artificial basins will have to be constructed without which the whole surface would be flooded. The poles of Mars are covered with ice and snow, the masses of glaciers contract and expand, according to seasons. Both poles are surrounded by seas, which are connected by straight canals, running through the whole continent. Those gigantic water-ways of 47 to 62 miles width show as dark straight lines, sometimes as two running parallel with each other, of which one appears lighter and narrower. If the ice melts on the North Pole, then the waters of the Arctic Sea, so to speak, rise and threaten to inundate the adjoining land, which perhaps does not project much above the sea-level. Then those canals, which have no other fall or grade than that caused by the difference of water-level, receive this super-abundance of water. Lest the flow of waters should exceed the high-water mark, there are parallel or auxiliary canals constructed, by whose aid the levelling process toward the South takes place. After a half year, when it is summer at the south pole, this is repeated toward the North. We see only one line, if the main canal is filled, but if the parallel one has received water, then there is a double line visible.

Beside the canals running from north to south we find some radiating or cross canals, at the junction points of which there are lake-like extensions of circular or rectangular, but in all cases regular form. These must have been shaped, without doubt, by human labor, with a view toward keeping as much land as possible dry in the inhabitable latitudes. The water is collected on the barren poles and only a minimum of land left to it. By suitable distribution of this element the denizens of Mars have control of the precipitation and evaporation of water, so they will not be left at the mercy of contingencies. The area of the water on Mars comprises a much smaller volume than on our Earth, because the interior of that planet in cooling contracts, and as the firm crust of the surface cannot follow this motion, great hollows will form between the two, which will fill with water, pouring through cracks in the crust. When once water has entirely disappeared from the surface in this way, then the atmospheric air will follow and the planet will become unfit for organic life, as we see in the moon, which, on account of her smallness, has reached that state at a comparatively early period.

While these apparent great artificial water-ways on Mars seem to us beyond the reach of unaided human enterprise and skill, perhaps when we have learned the simple art (as it possibly is) of converting into useful work 100% of the energy in heat, instead of only 3 to 10%, we may take a different view of the matter; beside which, there is the possibility involved in Dr. CROOKE'S statement that 10,000 ft.-tons of potential energy lie locked up in each cubic foot of the inter planetary ether, awaiting the great discoverer who shall unlock them. Perhaps the Martians have "got onto" the solution to this problem.

ELEMENTS OF WEATHER IN THE UNITED STATES, OF MOST INTEREST TO ENGINEERS, FOR THE MONTH OF NOVEMBER, 1891.

[Furnished to ENGINEERING NEWS by the Department of Agriculture.]

	STATION.	Temperature. (Deg. Fah.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Max.	Direction at time of max. velocity.	Precipitation — rain and melted snow. Inches. Total.	Heaviest in 24 hours.	Number of rainy days.
NORTHERN CITIES.	Northfield, Vt.	32.6	62	17	45	10.6	45	S	2.14	0.94	10
	Portland, Me.	38.0	56	6	50	9.1	46	S	2.38	1.10	8
	New York City	43.8	64	10	54	12.5	47	SE	2.06	0.53	9
	Pittsburg, Pa.	42.3	76	16	60	7.0	28	SE	2.61	0.70	14
	Chicago, Ill.	33.8	60	3	57	20.0	51	S	3.83	0.84	11
	Omaha, Neb.	34.2	68	-2	70	8.4	34	NW	0.37	0.15	5
	St. Paul, Minn.	25.8	58	-12	70	6.4	24	SE	1.63	0.69	5
	Duluth, Minn.	25.2	48	-8	56	5.9	30	NW	1.11	0.58	8
	Bismarck, N. Dak.	23.0	63	-11	74	9.8	50	NW	1.20	0.56	12
	Average	33.2	61.7	2.1	59.6	10.0	39.4	.....	1.86	0.68	9
SOUTHERN CITIES.	Washington City	44.0	68	17	51	6.5	54	SW	1.47	0.43	8
	Louisville, Ky.	44.4	71	15	56	7.8	35	W	6.23	2.49	19
	St. Louis, Mo.	41.2	68	10	58	13.0	37	NW	5.30	1.84	12
	Savannah, Ga.	55.6	79	30	49	7.6	26	NE	2.05	0.95	10
	Leavenworth, Kan.	38.7	80	8	72	7.6	28	S	0.80	0.24	6
	Jacksonville, Fla.	60.0	80	33	47	6.8	28	SW	1.53	0.65	9
	Chattanooga, Tenn.	48.8	72	18	54	6.4	34	SW	4.49	1.66	9
	New Orleans, La.	60.0	80	30	50	9.9	36	N	3.31	1.45	10
	Memphis, Tenn.	49.2	75	20	55	7.6	36	NW	4.79	1.44	10
	Palestine, Tex.	56.2	86	26	60	6.7	24	NW	4.09	1.83	7
	Average	49.8	75.9	20.7	55.2	7.9	33.8	.....	4.31	1.39	10
WESTERN CITIES.	Helena, Mont.	34.0	68	-8	76	8.8	48	SW	0.82	0.36	7
	Port Angeles, Wash.	44.9	60	29	31	3.6	34	W	6.24	1.25	24
	San Francisco, Cal.	58.6	78	47	31	4.3	24	W	0.56	0.26	5
	Salt Lake City, Utah	44.2	72	20	52	4.5	26	NW	0.90	0.48	8
	Denver, Colo.	37.8	75	2	73	7.7	50	NW	0.69	0.28	7
	Yuma, Ariz.	64.7	92	36	56	5.3	33	N	.....	.....	0
	Santa Fé, N. Mex.	40.8	66	17	49	7.4	32	NE	0.13	0.13	1
	Average	46.4	73.0	20.4	52.6	5.9	35.3	.....	1.33	0.39	7

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Cleveland, Wooster & Western.—This company, which has nearly completed a railway from Lodi to Wooster, O., 20 miles, asks the city of Wooster to subscribe $75,000 toward the purchase of right of way and terminal grounds in that place, on condition that it extends its line south to Holmesville or Millersburg, O.

Dutchess County.—Tracklaying has now been completed to a point about one mile north of Wappinger's Creek from Hopewell Junction, N. Y. Grading is well advanced on the remainder of the line and it will probably be completed within a month.

Concord & Montreal.—The engineers of this company have completed a survey for the line from Exter to Epping, N. H.

Buffalo, Rochester & Pittsburg.—A correspondent sends us the following:

The contract for building the Johnsonburgh & Bradford R. R. has been let to Brendlinger, Nearing & Kelly, of New York. The road extends from Howard Junction, south of Bradford, Pa., to Mt. Jewett, Pa. It is 20 miles in length, with light grades and easy curvature. The quantities average about 30,000 cu. yds. of excavation to the mile. There are no bridges or tunnels on the line. The road is to be built in the interest of the Buffalo, Rochester & Pittsburg Ry. Co., and when finished will be operated by that company. The route runs around the head of Kinzua Creek and, in the operation of the new line, the well known Kinzua viaduct will be entirely avoided. J. M. Floesh is Chief Engineer of the road, with headquarters at Bradford, Pa. The firm of contractors is made up of P. F. Brendlinger and Frank Nearing, both of New York City, and Edward J. Kelly, recently of Philadelphia. Brendlinger and Nearing are at present engaged in completing contracts for grading on the Lehigh Valley R. R., the Philadelphi & Reading R. R. and the Pittsburg, Fort Wayne & Chicago R. R.

Lehigh Valley.—A press dispatch says:

The Lehigh Valley has made such rapid progress on its western extension that it may by next month have its through line finished from Jersey City to Suspension Bridge, N. Y. The double track road from Ithaca to Geneva, N. Y., and from Geneva to Batavia, N. Y., has been completed, and the Tonawanda branch of the New York Central & Hudson River R. R., which it has just leased, gives it a route into Suspension Bridge. The main line into Buffalo is also being rapidly pushed. The work has reached a point 10 miles west of Batavia. At the eastern end of the line the road is completed to a connection with the Lehigh Valley terminal in Jersey City, with the exception of a strip across the Bergen Neck at Greenville. The work on the Bergen Neck between Greenville and Communipaw, where the Lehigh Valley will cross the Jersey Central over the bridge of the National Docks, is completed. The Bergen Neck will be extended to Constable Hook, where the Standard Oil Co. has its works, and the Lehigh Valley will build extensive coal docks for tidewater shipment.

New York, New Haven & Hartford.—This company has completed the second track between Leete's Island and Clinton, Conn., 10.5 miles, and between East Lyme and New London, 7 miles, on the Shore Line Division. On the New York Division 12.5 miles of the four-track im-

provement between South Norwalk and Bridgeport, Conn., have been completed.

Cleveland & Pittsburg.—This company has given a mortgage of $10,000,000 to the Farmers' Loan & Trust Co., of New York City. The proceeds are to be used in paying off the company's indebtedness and further constructing and equipping the road.

Little Falls & Dolgeville.—This company has let the contract for the rails necessary to complete its line from Little Falls to Dolgeville, N. Y. There will be two bridges on the line having spans of 175 ft. and 575 ft. Both have been contracted for.

Philadelphia & Reading.—The trestle work, docks and dredging are now nearly completed on the Port Reading R. R. and tracklaying is being rapidly pushed.

Baltimore & Ohio.—A press dispatch says:

The Baltimore & Ohio R. R. Co. has made an important move toward southern extension by the purchase of the Georgetown Railroad dock, elevator and barges in Georgetown, D. C. The Georgetown R. R. gives the Baltimore & Ohio an entrance into that city, and will be used by the latter in connection with the Metropolitan Southern, now being constructed by the Baltimore & Ohio to effect a southern connection. The Metropolitan Southern begins at Linden Station, on the Metropolitan branch of the Baltimore & Ohio, in Montgomery Co., and runs to the Potomac River, about 8 miles. The Potomac will be bridged at or near Great Falls, and the extension will be continued in Virginia to unite with the Virginia Midland.

Western Maryland.—Subscriptions are being asked from the people along the route in aid of the proposed line from Porter's Station to York, Pa., 15 miles.

Baltimore & Lehigh.—This railway from Baltimore, Md., to York, Pa., 79 miles, will, it is stated, be changed to standard gage.

Projects and Surveys.

Black River.—A correspondent writes us that surveys are now in progress between Springfield, Vt., and Claremont, N. H. The mountain section from North Springfield to Proctor, Vt., has been located, and work is expected to begin in the early spring. Possibly the bridges and trestles will be built this winter. There will be one two-span bridge 400 ft. long and three single span bridges, 130 ft., 150 ft. and 175 ft. long respectively. The money necessary to build and equip the road its full length, 28 miles, has been secured. Geo. B. Ayre, of Perkinsville, Vt., is Chief Engineer.

Wheeling & Connellsville.—Surveys are reported begun for this proposed railway from Wheeling, W. Va., to Connellsville, Pa. Job Abbott, of Wheeling, W. Va., is Chief Engineer.

Buffalo & Youngstown.—It is rumored that a project is on foot to build a railway from Buffalo to Youngstown, N. Y.

Bangor & Aroostook.—The surveys for this Maine railway have now been completed from Brownville, Me., to Van Buren, Me., passing through the towns of Houlton, Presque Isle and Caribou. The surveys have been in progress since early this summer and according to reports a very favorable line has been secured. Its total length, excluding branches, will be about 175 miles. The engineers are now at work on the branches from Easton to Fort Fairfield, Me., and from Dyer Brook to Ashland, Me.

Konkapot Valley.—An act has been introduced into the Massachusettts Legislature to incorporate this company to build a railway from Mill Village, Mass., along the Konkapot River to the Connecticut line.

Plymouth & Middleboro.—President Thos. D. Shumway is reported as saying that all arrangements have been completed for the construction of this railway from Plymouth to Middleboro, Mass., and that contracts will be let within a week. The work will be under the supervision of J. W. Rollins, of Dedham, Mass.

SOUTHERN.—Existing Roads.

Morristown & Cumberland Gap.—This railway from Morristown to Corryton, Tenn., 40 miles, has been completed.

Florida, Georgia & Western.—Eleven miles of track have been laid on this railway and 31 miles of roadbed additional are graded, bringing the line to Aucilla River, 42 miles from Tallahassee, Fla. From the Aucilla River to the Suwaunee River, 10.2 miles, the surveys have been completed.—F. P. Damon, Tallahassee, Fla., Chief Engineer.

Charleston, Clendennin & Sutton.—The contracts have been let for building the first 30-mile section of this proposed railway from Charleston, W. Va., up the Elk River to Braxton, W. Va. President, F. A. Abney, Charleston, W. Va.

Terracia Phosphate Co.—The grading on this 3½-mile railway from the Terracia Phosphate Co.'s mines to the South Florida R. R. has been completed. T. L. Marquis, of Bartow, Fla., was the contractor.

Danville & East Tennessee.—At a recent meeting of the directors of this reorganized company a committee was appointed to carry out the preliminary work necessary to the early construction of the road. T. W. M. Draper, General Manager, Norfolk, Va.

Union Ry. Co.—J. C. Rogers, Memphis, Tenn., Secretary, informs the *Manufacturers' Record* that this company is engaged in building a belt freight and passenger railway at Memphis, Tenn., to furnish all railways connection with the new steel bridge across the Mississippi River, and to provide a rapid system of handling cotton.

Savannah, Americus & Montgomery.—This company has given a mortgage to the Mercantile Trust & Deposit Co., of Baltimore, Md., to secure an issue of $6,150,000 of bonds.

Ohio Valley.—It is reported that this company has leased the Clarksville & Princeton branch of the Louisville & Nashville R. R., and will carry out its proposed line between Princeton and Hopkinsville, Ky., by building a 6-mile line from the latter place to a connection with the leased line at Gracey, Ky.

Marietta & North Georgia.—The petition of this company for power to issue $300,000 of receiver's certificates to provide for improvements has been granted by the United States Court in Georgia, but owing to some legal complications the order will not be effective until the United States Courts in Tennessee confirm the action. The improvements contemplate the construction of a bridge across the Tennessee River at Knoxville, Tenn., the construction of terminals at the same place, and the relaying a portion of the track with new rails.

Richmond, Nicholasville, Irvine & Beattyville.—Work is making rapid progress upon the bridge over the Kentucky River at Irvine, on the extension from Irvine to Beattyville, Ky.

Norfolk & Western.—The Ohio extension has now been opened for traffic from Coal Grove, O., to Dunlow, Va., 53.5 miles, and from Kyle, W. Va., to Welch, W. Va., 23.7 miles. The bridge across the Ohio River has been completed as noted in our "Engineering News" columns.

Projects and Surveys.

Cumming & Norcross.—New surveys have recently been made for this proposed railway from Norcross, Ga., to Cumming, Ga., 20 miles. The work will include a 400-ft. bridge over the Chattahoochee River. A. T. Abbott, of Warsaw, Ga., is interested.

North Carolina.—A project is on foot to build a line of railway from Asheville or Hendersonville, N. C., to Estatoe Ford. W. A. Gash, of Brevard, N. C., can give information.

Chesapeake, Shendun & Western.—This company is to be chartered in Virginia to build a railway from a point on or between the Potomac and York rivers to the West Virginia State line. Among the incorporators are: H. M. Bell, J. N. Stubbs and Jed Hotchkiss.

Marion & Rye Valley.—Application has been made to the Virginia Legislature for a charter empowering the construction of a railway by this name from Marion, Va. into Rye Valley, a distance of 6 miles. S. P. Swain & Co., of New York City, are said to be interested.

Savannah, Jacksonville & Gulf.—This company has been chartered in Florida to build a railway from Savannah, Ga., to Tampa, Fla., a distance of 320 miles.

Thomasville & Tallahassee.—The engineering corps, under the direction of J. M. Cook, has about completed the survey for this line from Thomasville, Ga., to Tallahassee, Fla.

Parkersburg Belt & Terminal.—A company is being organized to build a 7-mile double track railway at Parkersburg, W. Va. The work will include a bridge over the Kanawha River.

Gainesville, La Crosse & Lake Butler.—Chartered in Florida to build a line of railway from Gainesville, Fla., north to Lake Butler, and south to Tampa Bay, a distance of 225 miles. Among the incorporators are Chas. L. Fildis, D. W. Hyde and J. E. Webster, all of Gainesville, Fla.

Tuscaloosa Coal & Iron Co.—This company has made a contract with F. M. Abbott for the construction of its proposed railway from Tuscaloosa, Ala., to the Maxwell coal seam. The road is to be completed and in operation within 15 months. L. F. Bellinger, Tuscaloosa, Ala., Chief Engineer.

Powellton & Pocahontas.—Evan Powell, Powellton, W. Va., President, writes us that this railway will be 60 miles long, and that 8 miles are already constructed.

NORTHWEST.—Existing Roads.

Sioux City, O'Neill & Western.—This company, which operates the Pacific Short-Line R. R., has completed its organization by the election of the following officers: President, F. C. Hills; Secretary, J. C. Coombs, and Treasurer, A. S. Garretson.

Rapid City, Missouri River & St. Paul.—The entire route of this railway from Rapid City to Pierre, S. Dak., has been decided upon. It will be from Rapid City east along Rapid Creek to the Cheyenne River, and thence to the headwaters of Bad River, and down that stream to Pierre. Work is in progress upon a section of 43 miles from Rapid City east. About 23 miles of the grading are now completed, and the remainder will be completed by Jan. 1, 1892. Work will then be discontinued until spring.

Chicago & Northern Pacific.—It is stated that this company has floated $6,000,000 of first mortgage bonds, the proceeds of which will be used in the completion of terminal facilities at Chicago.

Projects and Surveys.

La Salle & Bureau County.—A new location has been made for this 6¾-miles railway connecting the zinc works at La Salle, Ill., with the Chicago, Burlington & Quincy and Illinois Central railways, and the greater part of the right of way secured. Work will begin in the spring. Isham Randolph, Counselman Building, Chicago, is the Consulting Engineer.

Sioux City, Madison & Northern.—This company has secured nearly all of the right of way for its line between Sioux City, Ia., and Dell Rapids, S. Dak.

Duluth, Mesabi & Northern.—According to Duluth, Minn., newspapers, the contracts for the construction of this railway are about to be let. Contractors are stated to be looking over the ground.

Winnipeg & Hudson Bay.—Press dispatches say:

The latest news in reference to Hudson Bay Ry. matters is that Hugh Sutherland is making good progress with his financial arrangements in Europe. Surveyors are now at work locating the line and it is expected that the work of construction will be commenced in the spring. About 2,000 settlers have gone into Lake Dauphin Co. this year in anticipation of the line being constructed through it at an early date.

Mankato & Northeastern.—Organized at Mankato Wis., to build a railway from Mankato to Farmington, Wis., where connection will be made with the Chicago, Milwaukee & St. Paul Ry.

SOUTHWEST.—Existing Roads.

Baltimore & Ohio.—A press dispatch from St. Joseph, Mo., says:

A few days ago the officers of the Baltimore & Ohio system visited this city, but nothing was learned to their purpose. To-day it developed that they made proposition to citizens to extend their lines to the city and build extensive shops here if the people will give the road what is known as the Fowler tract, a piece of land worth $100,000. A citizens' committee has the matter in charge.

Chicago, Rock Island & Pacific.—The surveys for the southern extension of this road have been completed to Rush Springs, Ind. Ter., 50 miles south of Minco, the present terminus of the road.

St. Louis & Hannibal.—About 65 teams are now at work on the 3-mile line from Oakwood to Hannibal, Mo. The cross ties for the line from New London to Perry, Mo., are being distributed, and tracklaying will probably soon begin.

Projects and Surveys.

Dardanelle & Mt. Nebo.—A press dispatch says:

A mass meeting of citizens was held Dec. 10 at Dardanelle, Ark., for the purpose of devising ways and means for the building of a railroad from Dardanelle to the summit of Mt. Nebo. Several gentlemen from Little Rock were present. The road is estimated to cost $40,000, and it is expected to be completed by June 1, 1892. Directors have been elected, articles of incorporation adopted, and a committee selected to open books of subscription.

St. Louis, Collinsville & Carondelet.—This company, which proposes to build a railway from Madison to East Carondelet, Ill., 50 miles, has filed a mortgage to secure an issue of $1,500,000 of bonds to be used in building and equipping its road.

Pan American.—A large quantity of the contractors' plant has arrived at Victoria, Tex., and according to the newspaper reports construction is to begin at once. The road is projected to run from Victoria to Brownsville, Tex.

ROCKY MT. AND PACIFIC.—Existing Roads.

Coos Bay, Roseburg & Eastern.—Sufficient rails to complete this road to Coquille City, Ore., have been ordered and will be laid immediately upon their arrival. Already 10 miles of track have been laid from Marshfield south and the remaining distance to Coquille City will be about 10 miles farther.

Rio Grande Southern.—On Dec. 6 only 20 miles of track remained to be laid on this line from Telluride to Durango, Colo.

Great Northern.—The Coulee City, Wash. *News* contains the following description of the route and character of the work on the Pacific extension across Washington:

The distance between Stevens Pass and Wenatchee, at the junction of the Columbia and Wenatchee rivers is 56 miles. The distance between Wenatchee and Chattaroy is 160 miles. These represent the two divisions of the Shepard, Seims & Co. contract. It is said that Shepard, Seims & Co. will sublet the contract to other contractors. Of the 160 miles between Chattaroy and Wenatchee, 120 miles will be very easy railroad building. The road will cross the Big Bend country, and there will be no heavy work except in crossing the Grand Coulee and entering the Moses Coulee, as the road runs down the Moses Coulee to the Columbia River. There will be some heavy work from the mouth of the Moses Coulee to Rock Island, as the country there is rough, broken and precipitous. The rough country is only about 6 miles in extent. From Rock Island Rapids the road follows the Columbia River, up the east bank of the Columbia River till opposite the Wenatchee.

The bridge has been permanently located at this point, and the road will cross the Columbia River east of the town. There is a good crossing here, as an island in the middle of the river gives a fine foundation for the piers. There were four crossings reported on, but this was the one selected. The bridge, with its approaches and all, will be some 3,200 ft. in length, and it will cost about $500,000.

The road from Wenatchee to Stevens Pass will follow up the Wenatchee River, crossing that stream twice within 21 miles of the town of Wenatchee. It will closely follow the bank of the river. The first heavy work will be at Tumwater Cañon. It is about 8 miles long, and offers considerable physical difficulties to railway building. After passing through Tumwater Cañon the road follows the Wenatchee River until a point is reached 6 miles below Wenatchee Lake, at which place the road follows through a low sag and strikes Nason Creek, a tributary of the Wenatchee River, 6 miles above the creek's mouth. The road follows up the creek a distance of about 18 miles till the mouth of the tunnel in Stevens Pass is reached. The tunnel will be about 8,060 ft. long.

It is understood that Shepard, Seims & Co. must complete the 213 miles of track inside of a year. The tunnel may take longer to build. If that is the case a switchback will be constructed pending the completion of the tunnel.

In regard to the construction work west from Pacific Junction, Mont., the Spokane *Chronicle* says:

There is a large force of men now at work between Crossport and Bonner's Ferry, Mont., 6 miles. It is estimated that between Bonner's Ferry and the Halfway House on the Burns & Jordan, Tom Wren, Griffin & Pond and other contracts, covering a distance of 17 miles, there are 2,000 men and about 1,000 teams. From the Halfway House to Sand Point, Idaho, it is said that considerable work remains to be done, and some of the contractors estimate that it cannot be completed before March 14, 1892. The Welsh contract west from the Halfway House will be complete about Jan. 1, 1892. The work on the contract held by the San Francisco Bridge Co., from Sand Point to Albany Falls, is nearly complete, with the exception of the bridge. Hall & Wright, who have the tie contract from Libby Creek to the Halfway House, a distance of about 65 miles, will have their contract complete by Dec. 15. M. D. Wright & Co. have the tie contract from the Halfway House to Chattaroy, and the work is about half done.

Southern Pacific.—Work will be commenced on the gap between Santa Margarita and Elwood, Cal., in a few days, and the Pacific Improvement Co. has issued proposals for bids for the construction of tunnels. The company announces that bids will be received up to Dec. 31, 1891, for the grading of two tunnels, one 3,000 ft. and the other 1,400 ft. long respectivly, on the first 4.4 miles of the Southern Pacific R. R. south of Santa Margarita. Bids for the remaining 125 miles of the Southern Pacific R. R., from Santa Margarita to Elwood, will be called for hereafter.

Projects and Surveys.

Columbia River & Astoria.—Chief Engineer W. H. Kennedy has submitted his report upon the survey of this line. According to the route selected the distance from Astoria, Ore., to Goble, Ore., will be 58 miles. The work will be about average; maximum grade 16 ft. per mile and maximum curve 8°. There will be four draw spans, two 75 ft. and two 60 ft., and 7⅛ miles of trestle.

Blue Canon.—This company will soon be incorporated to build coal bunkers and a railway to connect the Blue Cañon coal mines with the Puget Sound at Fairhaven, Wash. As soon as the company is legally incorporated, contracts for the construction of the road and bunkers will be let and orders for equipment and rolling stock will be placed. The work will be let in three contracts. One contract will include the construction of the entire road, the contractor to furnish everything but the steel, which will be furnished by the company. For the construction of the bunkers two contracts will be awarded, one for the work and the other for the material. The contract for the railway will be let first.

Paso Robles & Cayucos.—Incorporated in California to build a railway from Paso Robles to Cayucos, about 30 miles. Directors: George R. Adams, H. Eppinger, E. A. Stowell and O.C. Bryant, of Paso Robles; M. M. O'Shaughnessy and J. N. E. Wilson, of San Francisco; A. F. Jack, of San Luis Obispo and J. W. Watson and A. M. Hardie, of Cayucos.

San Francisco & Eastern.—Chartered in California to build a line of railway from San Francisco Bay to Rogers, Kern Co., Cal., 380 miles; also from Hanford to Indian Wells, Kern Co., Cal., 100 miles. Among the incorporators are: H. J. Brady, J. R. Howell and C. L. Weller, all of San Francisco, Cal.

Sidney & Southern.—Chartered in Washington to build a railway from Sidney, Wash., to Portland, Ore., passing through Kitsop, Mason, Chehalis, Lewis, Cowlitz and Clark counties in Washington.

FOREIGN.

Mexico.—The Mexican Government has granted a concession to Rafael Dorantez for two lines of railway, one from Ermita to Teapa in the state of Tebasco, and one from Paraiso to Conduacan, in the same state. The concession also grants authority to construct branch lines.

A concession has also been granted for a railway from Toluca to Tenango, with branch lines to Tianquistenzo and Calimaya.

Port Angeles Southern.—The surveys for this projected railway from Port Angeles to Junction City, Wash., have been completed. It will be 32 miles long and very easy to construct. The maximum grade will be 2%.

Chicago, Iowa & Western.—Surveys are in progress for this line from Thompson to Esther, Ia. It is rumored to be in the interest of the Burlington, Cedar Rapids & Northern Ry.

Mexico, Cuernavaca & Pacific Construction Co.—This company has been incorporated to build the Mexico, Cuernavca & Pacific Railway from the City of Mexico to the Pacific coast. The principal offices will be at Denver, Colo.

CITY TRANSIT.

Electric Railways.—***Lowell, Mass.***—The Lowell, Lawrence & Haverhill Street Ry. Co. is having surveys made for an electric road.

Brooklyn, N. Y.—The engineers of the Brooklyn City R. R. are preparing specifications and plans with a view to the adoption of electric traction.

New York, N. Y.—The New York Electric Ry. Co. has been incorporated at Jersey City, N. J., by T. W. Alcott, Philip Payne and Benjamin Tuska, of New York, and J. W. Hyatt, of Newark, N. J., with a capital stock of $25,000. The company owns patents on a system of electric traction.

Norfolk, Va.—The Norfolk Rapid Transit Co. has been incorporated by Philip Corbin and Andrew Corbin of New Britain, Conn., and A. H. Rogers, of Virginia, with a capital stock of $500,000, and will use electric or other traction.

Belleville, Ill.—The Citizens Horse Ry Co. has been granted permission to adopt electric traction.

San Diego, Cal.—The San Diego Electric Ry Co. has been incorporated by A. B. Spreckels, of San Francisco; C. F. Hinde, of Coronado and J. A. Flint, of San Diego; with a capital stock of $250,000, to build lines aggregating 20 miles in length.

Pomona, Cal.—A storage battery line 7 miles long is to be built. The plant will be operated by water power. The Pomona Electric Co. is interested.

Elevated Railways.—***Philadelphia, Pa.***—The Quaker City Elevated Ry. Co. has been granted a charter for a line from Front and Market Sts. to Ridge and Lehigh Aves., with a band to Cobb's Creek. The length will be about 12 miles. Capital stock, $150,000. Director, Wm. B. Stout. The Northeastern Elevated Ry. has awarded construction contracts to the Phœnix Iron Co., of Phœnixville, Pa., and Cooper, Hewitt & Co., of Trenton, N. J.

HIGHWAYS.

New Jersey.—A road convention, to be held at the State House, Trenton, on Jan. 22, has been called for by the State Board of Agriculture.

Kansas.—A road improvement company has been organized in Adair Co.

Colorado.—A wagon road is proposed in Hinsdale Co. from Carson to Lost Trail.

BRIDGES, TUNNELS AND CANALS.

Bridges.—***Amsterdam, N. Y.***—A bridge will probably be erected at this place.

Duluth, Minn.—Plans are being asked for a bridge over the Duluth Ship Canal. Address T. W. Abell, Clerk, Board of Public Works.

St. Louis, Mo.—Plans have been completed for the proposed Twelfth St. bridge. The structure will be 2,100 ft. long, with a 30 ft. roadway, and two 10-ft. sidewalks. The estimated cost is $250,000.

Tunnels.—The New York & Queens Co. Tunnel R. R. Co. has been chartered in New York to build a tunnel between New York and Jersey City. Ed. J. Boyle and Jas. J. Byrne, Brooklyn.

WATER-WORKS.

NEW ENGLAND.

Bellows Falls, Vt.—The voters have adopted a report calling for an increase in the height of the reservoir dam, and the turning of Farr Brook into the reservoir, which will necessitate the building of another dam and the laying of a conduit.

Medfield and Medway, Mass.—Edwin V. Mitchell, Clinton T. Frost and Henry M. Parker have petitioned for authority to supply these towns.

Willimansett, Mass.—Two petitions for charters to supply this place have been presented to the legislature. The petition of C. L. Goodhue, Springfield, it is reported, has been indorsed by the residents of the village. The other petition was noted last week under Chicopee and South Hadley.

Hartford, Conn.—The proposed new reservoir to be located in Bloomfield has been ordered by the Council, together with the issuance of $48,000 of bonds to help pay for the same. It is said that the bonds will probably be taken for the city sinking fund.

MIDDLE.

Afton, N. Y.—It is reported that works are projected by Brooks & Lamb, Cooperstown.

Arena, N. Y.—Works are talked of.

Medina, N. Y.—Bids for the construction of works are wanted. Address A. J. Hill for further information.

Boiling Springs, N. J.—The Boiling Springs Water Co. has been incorporated by Miles Tierney and C. B. Brush, of New York City, E. A. Stevens, Hoboken, and other; capital stock, $100,000.

Garfield, N. J.—A supply from the Acquackononk Water Co. of Passaic is talked of, but it seems that nothing definite can be done until legislation is secured.

Hoboken, N. J.—The New Jersey Shore Water Co. has been incorporated by H. S. Lansdell, Brooklyn, N. Y., I. W. Cook, Hoboken, and others, to build and operate works. Capital stock, $250,000, of which $1,000 is paid in.

Perth Amboy, N. J.—The council has adopted the report of the Fire and Water Committee recommending Tennent's Brook as a source of supply. The plan proposed includes a 16-in. submerged main some 2,000 ft. long across the Raritan River. The estimated cost of the works, including the purchase price of the company's works, now under condemnation to determine the price to be paid, is $200,000. James C. Rossi is engineer for the city.

Landsowne, Pa.—It is reported that the Landsowne Water Co. has just decided to lay a new main to Darby in the spring and to add a 1,000,000-gall. tank or reservoir.

Stroudsburg, Pa.—The company has bought 100 acres of land, including a new supply, and proposes to pipe the latter to the town.

Catonsville, Md.—The Catonsville Water Co., it is reported, will build a reservoir.

Cumberland, Md.—Steps are being taken by the Council to secure authority to procure a better supply.

Elkton, Md.—The Maryland Water Co. has let a contract for works.

Lonaconing, Md.—It is said that subscriptions to the stock of the new company are being rapidly secured.

Middletown, Md.—The *Register* urges the organization of a water company.

SOUTHERN.

Yorkville, S. C.—A bill has passed the House authorizing the town to build works.

Gainesville, Fla.—The contract for works has been let to Hartford, Hebert & Co., Chattanooga. A 2,500,000-gall. steam pumping plant will be furnished by the Laidlaw & Dunn Co., Cincinnati, O.

Piedmont, Ala.—The Council has voted to grant a franchise to George D. Harris and associates.

Harriman, Tenn.—It is reported that the East Tennesse Land Co. has granted to a company the privilege of building works.

Catlettsburgh, Ky.—The Catlettsburgh Water Co. has completed its works and they have been accepted. W. A. Patton is President and T. R. Brown is Secretary and Treasurer.

NORTH CENTRAL.

Steubenville, O.—The trustees are considering the introduction of a filtering plant after the new pump is completed.

Anderson, Ind.—It is reported that new improvements will be made by the city at a cost of $100,000.

Logansport, Ind.—Councilman William Dolan has suggested that a pump be added.

Northville, Mich.—Dec. 21 the people will vote on the issuance of $30,000 of bonds for works.

Belleville, Ill.—The Council has instructed the Waterworks Committee to advertise for bids for constructing works. The City Water Co. built works in 1885.

Monmouth, Ill.—Improvements to the city works are talked of. Address R. G. Young, of the Fire and Water Committee.

Pana, Ill.—The construction of new works is being considered. Address N. W. Martin, Mayor.

NORTHWESTERN.

Creston, Ia.—The new works have been completed.

Washington, Ia.—The works were recently completed, with G. W. Wynn, Cedar Rapids, Iowa, as engineer.

Graceville, Minn.—It is reported that works are to be built.

Granite Falls, Minn.—On Dec. 11 the people voted to issue $12,000 of 7% bonds for water and electric lighting plants.

Saratoga, Wyo.—The Saratoga Water Co. has filed articles of incorporation, and elected W. A. Remington Secretary and Treasurer. The company's authorized capital stock is $50,000. Water will be furnished to the west-side addition for fire, domestic and irrigating purposes and to outside lands for irrigation.

SOUTHWESTERN.

Batesville, Ark.—A franchise for water and electric lighting plants will probably be granted to J. E. Hart, Hot Springs.

Denison, Tex.—The city will add a 2,000,000-gall. pump. Address M. J. Fitzgerald, Superintendent.

Fort Worth, Tex.—The contract for the new city works has been awarded to McArthur Bros., Chicago, represented by John B. Hawley, St. Paul; price, $658,000.

Overton, Col.—Works for a general supply and for irrigation are proposed.

PACIFIC.

Nelson, Wash.—It is reported that attempts are being made to form two companies.

Athena, Ore.—It is reported that this place will soon have works.

Portland, Ore.—Bids are wanted by the city until Jan. 4 for clearing and grubbing over five miles of right of way, 33 ft. wide, for the Bull Run pipe line. J. W. Smith is Superintendent.

Yuma, Ariz.—The Yuma Water & Manufacturing Co. has filed articles of incorporation in Los Angeles, the object being to acquire a franchise, build and operate waterworks in Yuma; capital stock, $50,000, of which $3,550 has been subscribed; Directors, A. A. Dougherty, Yuma; J. P. Culver, F. H. Jackson and others, Los Angeles.

Brigham City, Utah.—Mayor Jensen and Councilmen Steed and Pett have been authorized to take steps necessary for the building of works.

Mount Pleasant, Utah.—Works are projected. The council is investigating possible sources of supply. Ownership has not been determined.

Salt Lake City, Utah.—New mains will be laid on several streets.

Springfield, Utah.—E. C. Ragnon, Secretary of the Midland Construction Co., Salt Lake City, has been investigating the prospects for works here.

IRRIGATION.

Pomona, Cal.—A dispatch from this place states that the Fall Brook Irrigation District has just voted $400,000 of bonds for the development of water and laying of pipes.

San Bernardino, Cal.—F. C. Finkle, of this place, is preparing plans for the reservoirs and distributing system of the East Riverside Irrigation District, and will soon investigate and report upon works for the Grapeland Irrigation Districts.

New Companies.—Owl Creek Ditch & Reservoir Co., Greeley, Colo.; $6,000; J. W. Vail, W. J. and Emma C. Farr. La Sierra Land Co., Riverside, Cal.; $1,000,000; to deal in real estate and water rights, and to build water-works. Marysville Canal & Irrigation Co.: $10,000; to take water from Fall River, Bingham Co.

SEWERAGE AND MUNICIPAL.

Sewers.—*Massachusetts.*—Lynn. The plan of Mr. Rudolph Hering, of New York, for the new outfall sewer has been accepted, and construction will begin soon. The sewer will be 2,400 ft. long, and consist of a covered wooden channel 8 ft. × 6 ft., divided vertically into two similar compartments throughout its entire length.

Rhode Island.—Providence. An additional $100,000 has been appropriated for the new lateral sewers.

New York.—White Plains. The Board of Trustees has rescinded its resolution to do away with the Powers patent system of sewerage, having been shown that the village would be liable for $36,500, the amount of Power's contract, should they annul their contract with him.

Maryland.—Cumberland. The City Council has granted a franchise to the Lewis Mercer Construction Co., of New York.

Iowa.—Des Moines. Plans for the North Des Moines sewerage system have been prepared. About 5 miles will be constructed early next spring in this one district.

Michigan.—Detroit. The City Engineer is preparing plans for 3 new tunnel sewers to be built with the $500,000 appropriation.

Minnesota.—St. Paul. City Engineer Rundlett has decided upon a system of sewers for Ward 10. The estimated cost for the 3 districts into which he divides the ward is $225,009.

Missouri.—Springfield. Bids for sewer construction have been accepted as follows: Lillis & Glennon, Kansas City, Mo.; section 1, $46,470; section 2, $25,739; section 3, $16,954; section 5, $8,843; section 6, $13,234; section 7, $22,926; E. Plummer, Springfield, Mo.; section 4, $2,662.

Oregon.—Portland. Specifications have been prepared for sewers on R and West Main Sts. A brick sewer to serve as the main outlet for the whole system is now under construction in Holladay Ave.

Washington.—Colfax. A system to cost from $15,000 to $20,000 will be put in next year.

Streets.—*New York.*—Olean. A committee has been appointed to prepare a bill for amending the charter in relation to paving. Among the members are F. W. Kruse, W. B. Pierce and J. B. Smith. New York. Commissioner Heintz has approved specifications for improvements in German place, in the annexed district, which will include 450 cu. yds. of earth excavation, 5,000 cu. yds. of filling, 9,900 sq. yds. of flagging, 2,055 lin. ft. of curb, 630 sq. ft. of bridge stone and 425 cu. yds. of rubble masonry.

Indiana.—Indianapolis. The Board of Public Works has about completed its schedule of the streets to be improved during the coming year. The appropriation is $80,000 and this last year, with a similar sum from the city, the board has laid about 4½ miles of asphalt and 4½ miles of brick.

Illinois.—Jacksonville. Paving ordinances have been passed for next year amounting to $48,944.—Peoria. Several streets will be paved with asphalt and two with brick.

Missouri.—St. Louis. The street commissioner is preparing estimates for granite block paving on 16 streets.

California.—Coronado. The city engineer estimates that it will cost $140,000, or $311 for each lot of 25 ft. to pave Orange Ave.—Santa Barbara. Asphalt driveway and sidewalk for the proposed boulevard is estimated at $21,560.

Bonds.—Columbus, Ga.: $175,000 for a system of sanitary sewage, to be voted on Jan. 16. Duval Co., Fla., $300,000 for improving and deepening the St. John's River. Victoria, B. C.; $300,000 for sewerage. Portland, Ore.; $100,000 for river improvement.

Gas.—*New York, N. Y.*—Commissioner Gilroy has received the following bids for gas lighting for next year: Equitable Gas Co., $12 per lamp; Standard, $12.01½; Consolidated, $17.50; Mutual, $17.50; Central (Twenty-third Ward), $27. Northern (West Farms), $28; New York & New Jersey Globe Gaslight Co. (naphtha for Woodlawn Heights), $22 per lamp.

ELECTRICAL.

Electric Light—*New York, N. Y.*—The following bids have been received for electric street lighting for next year: Brush Co., 151 lamps at 40 cts., 114 at 45 cts. per light per night; United States Co., 235 lamps at 40 cts., 66 at 45 cts.; East River Co., 247 lamps at 40 cts., 16 at 60 cts.; Mount Morris Co., 154 lamps at 40 cts.; Harlem Co., 181 lamps at 40 cts., 15 at 45 cts., 19 at 50cts.; North New York Co., 248 lamps at 45 cts.

Philadelphia, Pa.—Mr. Windrim, Director of Public Works, has awarded the contracts for the city electric lighting for 1892, amounting to 1,747 lamps and a total cost of $271,268, as follows:

Company.	No. of lights.	Price per light per year.
Brush	421	$143.07
Southern	244	166.46
Frankford Ave. Mer.	211	142.74
Philadelphia	126	152.93¾
United States	94	155.55
Northern	146	117.73¾
Diamond	79	156.12
Manufacturers'	64	183.00
Powelton	148	172.02
Wissahickon	46	201.30
Germantown	67	201.30
Suburban	55	201.30
Philadelphia Illuminating Co.	46	128.10

Richmond, Va.—The Committee on Electric Light desires bids for furnishing the city with from 300 to 500 lights of 2,000 c. p. each for 2 and 4 years.

Henderson, N. C.—Bids for 17 lights of 1,200 c. p. will be received by the Town Clerk until Dec. 28.

Mobile, Ala.—The City Clerk will receive bids until Dec. 31 for the erection of a 200-arc light plant and for a contract for furnishing the city 101 arc lights.

New Companies.—Belleville Electric Light Co., Belleville, N. J.; A. F. Crawford, Edward S. Frazer and H. V. Cole; $100,000.——Owatonna Electric Co., St. Paul, Minn.; Henry M. Byllesby, Geo. C. Duffie and W. P. Johnson; $25,000.——Phillipsburg-Granite Electric Co., Phillipsburg, Mont.; Geo. P. Durham, John Cox and John M. Evans; $50,000.——West Jamaica Electric Light Co., West Jamaica, N. Y.; Geo. Lester, Wm. Kessler and O. W. Graves; $25,000.——Crocker-Wheeler Electric Co., Jersey City, N. J.; F. M. Jeffrey, W. H. Geers and W. H. Crocker; $200,000.

CONTRACTING.

Street Works.—*Omaha, Neb.*—The contract for paving Sherman Ave. with Colorado redstone has been awarded to Hugh Murphy at $1.69 per sq. yd. He was also awarded the contract for Colorado redstone curbing for the same at 63 cts. per lin. ft. Katz & Callahan were awarded contract to grade Chicago St. at 15 cts. per cu. yd. and grading alleys at 19 cts. per cu. yd. Charles R. Lee will replank the Sixteenth St. viaduct with either pine or oak at 57 cts. per sq. yd.

Pottsville, Pa.—The contract for the construction of the Race St. culvert has been awarded to W. K. Boltz at $2.40 per ft. The culvert will be 306 ft. long.

La Crosse, Wis.—The contract for macadamizing the road between La Crosse and Onalaska has been awarded to Leopold Perris at 75½ cts. per lin. ft. for a road 20 ft. wide and 12 ins. deep.

Sewers.—*Marquette, Mich.*—The contract for section 2 of the trunk sewer has been awarded to Wm. O'Meara at $1.40 per lin. ft.; manholes, $50 each; lampholes, $3 each; rock per yd., $3. The Prospect St. sewer contract was awarded to John Mitchel; 8-in. pipe, 74 cts. per lin. ft.; 6-in. lateral pipe, 64 cts.; manholes, $45 each; lampholes, $1.50 each; rock, $2.50 per cu. yd.

Wreck.—The following bids for removing the wreck of schooner *Python*, off Pollock Rip., Mass., have been opened by Captain Bixby, U. S. Engineer Office, Newport, R.I.: Davis Coast Wrecking Corporation, New Bedford, Mass., $2,973; Wm. E. Chapman, New York, N. Y., $4,000; Chas. W. Johnston, Lewes, Del., $5,900; Enoch Townsend, Somer's Point, N. J., $6,785.

PROPOSALS OPEN.

Pipe and Iron Work.—*Toronto, Ont.*—Sewer pipe and wrought and cast iron work for year 1892. John Shaw, Chairman Committee on Works. Dec. 29.

Bridge.—*Boston, Mass.*—The L St. Bridge. Wm. Jackson, City Engineer. Jan. 5.

Grading.—*Boston, Mass.*—Grading at Wood Id. Board of Park Commissioners. Dec. 23.

Pumping Engines.—*Chicago, Ill.*—Two sewage pumping engines; one with a capacity of lifting 12,000,000 and the other 24,000,000 galls., 15 ft. high, in 24 hours. Also 3 boilers with necessary appurtenances. J. F. Aldrich, Commissioner of Public Works. Dec. 29.

Elevators.—*Cincinnati, O.*—Elevators for the new City Hall. City Hall Trustees. Dec. 31.

Tunnels.—On the Southern Pacific; 3,600 and 1,400 ft. long. Pacific Improvement Co., San Francisco, Cal. Dec. 31.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., have orders for 40 engines for the Philadelphia & Reading, and 10 for the Long Island. The Brooks Locomotive Works, of Dunkirk, N. Y., have completed the first of 10 engines for the Lake Shore & Michigan Southern.

Cars.—The Gilbert Car Mfg. Co., of Troy, N. Y., has an order for 12 passenger cars for the Delaware & Hudson. The Ohio Falls Car Co., of Jeffersonville, Ind., is building 24 passenger cars for the Louisville, New Albany & Chicago, and 400 box cars for the Cincinnati, New Orleans & Texas Pacific. The Osgood-Bradley Car Works, of Worcester, Mass., are building 50 passenger cars for the New York, New Haven & Hartford. The Lehigh Valley Car Works, of Stemton, Pa., have an order for 500 gondola cars for the New Jersey Central. The Roanoke Machine Works, of Roanoke, Va., have an order for 500 coal cars of 60,000 lbs. capacity for the Norfolk & Western.

Steel Ties.—The Railway Improvement Co., of Chicago, Ill., has been incorporated by A. J. Hartford, of New York, and H. N. Hibberd and A. G. Wheeler, of Chicago. The purpose of the company is to manufacture the Hartford steel tie, now in experimental service on the New York Central & Hudson River.

The Nash Meter, manufactured by the National Meter Co., of New York, has been officially approved for use in this city upon the recommendation of Mr. G. W. Birdsall, Chief Engineer, and Mr. T. F. Gilroy, Commissioner of Public Works. The meter was patented in March, 1891. The company claims that the meter has but one free moving piston, no piston controlling mechanism, no small connections to adjust or to wear out, and that it is low priced and efficient. The company is putting up a new factory.

Eppinger & Russell, of New York, have had a very bad loss by fire at their creosoting works in Long Island City, but are making arrangements to get the plant repaired, and will be ready to commence work inside of 60 days. The plant will be rebuilt to its power capacity of 80,000 ft. B. M. per day.

The American Bridge Works, of Chicago, Ill., are furnishing about 1,400 tons of steel for the Ogden Ave. viaduct, Chicago. This company was incorporated in May, 1891. President, Paul Richter; Secretary, W. B. Lee.

The Laidlaw & Dunn Co., of Cincinnati, O., will furnish the steam pumping plant for elevators, house service and boiler feed for the Equitable Building, Atlanta, Ga. The contract for steam heating and steam plant has been awarded to the Hunnicutt & Billingraths Co.

H. Ward Leonard & Co., of New York have the contract for wiring the Mail and Express building for 3,500 incandescent lamps, acting as subcontractors under the Weddell-Entz Electric Co. They have also an order from Wm. Sellers & Co., of Philadelphia, for 2 motors of 40 HP. for traveling cranes. Mr. Leonard is licensing various manufacturing and construction companies under his patented system of motor regulation, on the basis of a royalty charge of $2.50 per K.W. (roughly per HP.) in the motor. Wm. Sellers & Co. have taken a license, agreeing to use the method on all the electric cranes they build.

New Companies.—Inland Construction & Equipment Co., of Spokane, Wash.; L. S. Howlett, B. H. Bennett and C. F. Clough; $20,000.——Fisher Smokeless Furnace Co., of Chicago, Ill.; W. F. Fisler, C. H. Sieg and W. J. Williams; $250,000.——Acme Pure Water Co., of Portland, Me.; to manufacture purifying apparatus; President, J. B. Kehoe, Portland; $100,000.——Automatic Torpedo Machine Co., of Elizabeth, N. J.; railway torpedoes and appliances; J. E. Febrey, C. S. Young and Geo. T. Chapman; $25,000.——Aroostook Construction Co., of Bangor, Me.; to build railways; E. L. Stewart, I. K. Stetson and H. H. Fogg; $50,000.——Peoria Construction Co., of Peoria, Ill.; G. T. and E. L. Spruck; $30,000.——Nowlin Safety Switch & Signal Co., of Chicago, Ill.; C. E. Nowlin, Charles Kirchner and W. G. Barnet.——Mekarski American Compressed Air Motor Co., of North Tarrytown, N. Y.; G. E. Whipple, of Westfield, Mass.; Edward C. Nichols, of Dunkirk, N. Y.; and A. C. Randall, of New York, N. Y.; $1,000,000.

Metal Market Prices —*Rails.*—New York: $30 to $30.50; old rails, $21 to $21.50 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $23 to $23.25 for iron and $17 to $18 for steel. Chicago: $31; old rails, $20.50 to $21 for iron and $14 to $15 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1.9 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.8 to 3 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.7 to 1.8 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.65 cts. with square and 2.75 cts. with hexagon nuts. Chicago: splice bars, 1.8 to 1.85 cts. for iron and steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.7 to 2.75 cts. with hexagon nuts.

Pipe.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

Foundry Pig Iron.—New York: $14.50 to $18. Pittsburg: $14 to $16. Chicago: $14.25 to $16.

Lead.—New York: 4.25 to 4.35 cts. Chicago: 4.05 cts. St. Louis: 3.9 to 4 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.9 to 2.1 cts. for tank, 2.15 to 2.3 cts. for shell, 2.4 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.5 to 2.6 cts.; universal iron mill plates, 2 to 2.05 cts.; sheared steel bridge plates, 2.1 to 2.2 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 1.95 to 2.1 cts. for tank, 2.15 to 2.2 cts. for shell, 2.35 to 2.4 cts. for flange, 3.75 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.05 to 2.15 cts.; tees, 2.4 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts.; steel plates, 2.2 cts. for tank, 2.6 to 3.5 cts. for shell, 2.6 cts. for flange.